UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest Region
7600 Sand Point Way N.E., Bldg. 1
Seattle, WA 98115

December 13, 2002

Magalie R. Salas, Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426

RE: Endangered Species Act section 7 consultation: Final Biological Opinion on the North Umpqua Hydroelectric (Project No. 1927-008) relicensing and interim conservation measures. NOAA Fisheries Consultation F/NWR/2002/00509.

Dear Secretary Salas:

Enclosed is the final biological opinion prepared by the National Marine Fisheries Service (NOAA Fisheries) on the Federal Energy Regulatory Commission's (FERC) proposed license and interim conservation measures. This document represents NOAA Fisheries' biological opinion of the effects of the proposed action on listed species in accordance with section 7 of the Endangered Species Act of 1973 as amended (16 USC 1531 *et seq.*). This biological opinion is also being provided to PacifiCorp as FERC's designated non-Federal representative.

In this biological opinion, NOAA Fisheries has determined that the proposed action is not likely to jeopardize the continued existence of Oregon Coast coho salmon. A complete administrative record of this consultation is on file with the NOAA Fisheries Hydro Program in Portland, Oregon.

In addition to the biological opinion, enclosed as section 10 is a consultation regarding essential fish habitat (EFH) under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267). NOAA Fisheries finds that the proposed action will adversely affect EFH for coho and chinook salmon and recommends that the Terms and Conditions of section 9 of the biological opinion be adopted as EFH conservation measures. Pursuant to MSA (§305(b)(4)(B) and 50 CFR 6000.920(j), Federal agencies are required to provide a written response to NOAA Fisheries' EFH conservation recommendations within 30 days of receipt of these recommendations.

Comments or questions regarding this biological opinion and MSA consultation can be directed to Keith Kirkendall of the NOAA Fisheries Hydro Program (503-230-5431).

Sincerely,

D. Robert Lohn

D. Robert Lohn
Regional Administrator

cc: John Sample, PacifiCorp
FERC Service List

Endangered Species Act
Section 7 Consultation

Biological Opinion

and

Magnuson-Stevens Fishery Conservation and Management Act Consultation

North Umpqua Hydroelectric Project

FERC Project Number 1927-008

Action Agency:	Federal Energy Regulatory Commission
Consultation Conducted by:	National Marine Fisheries Service Northwest Region Hydro Program
NMFS Log Number:	F/NWR/2002/00509
Date:	December 13, 2002

TABLE OF CONTENTS

LIST OF TABLES

1. OBJECTIVES AND BACKGROUND

1.1 Objectives

This is an interagency consultation between the Federal Energy Regulatory Commission (FERC) and the National Marine Fisheries Service (NOAA Fisheries) pursuant to section 7(a)(2) of the Endangered Species Act (ESA), and section 305(b) of the Magnuson-Stevens Act (MSA). NOAA Fisheries is responsible for administration of the ESA with respect to anadromous salmonids. NOAA Fisheries is likewise responsible for administration of the MSA and consultations conducted pursuant to the MSA's essential fish habitat (EFH) consultation requirements.

Section 7(a)(2) of the ESA requires Federal agencies to ensure their actions avoid jeopardizing listed species or adversely modifying designated critical habitat. Section 305(b)(2) of the MSA requires Federal agencies to consult with NOAA Fisheries if their actions may adversely affect designated EFH. The Federal Power Act (FPA) authorizes FERC to license certain privately owned and operated hydroelectric projects. FERC may likewise condition such licenses for the protection and mitigation of environmental resources, including listed species and designated habitats. Consequently, FERC must initiate consultation with NOAA Fisheries under the foregoing statutes if it determines its actions may affect ESA-listed species, or may adversely affect designated EFH.

The North Umpqua Hydroelectric Project (the Project) consists of eight dams and powerhouses and associated facilities located in southwestern Oregon, on the west side of the Cascade Range, in Douglas County, Oregon. The Project is located about 97 km (60 mi) east of the city of Roseburg, Oregon. PacifiCorp operates the Project pursuant to a FERC-authorized license (FERC No. 1927-008) which expired in 1997. In 1995, PacifiCorp filed an application with FERC seeking a new Project license. As discussed below, the license application was recently updated to include the terms of a Settlement Agreement (SA) between PacifiCorp and the various Federal and state resource agencies possessing prescriptive authority in this matter, including NOAA Fisheries (PacifiCorp et al. 2001). The SA is intended to address all of the resource agencies' mandates and requirements as they relate to this relicensing proceeding.

By letter dated August 20, 2001, FERC designated PacifiCorp as its non-Federal representative in accordance with applicable regulations. On February 15, 2002, PacifiCorp provided a draft biological assessment (BA) to NOAA Fisheries for its consideration. On May 7, 2002, FERC transmitted a letter to NOAA Fisheries requesting initiation of formal section 7 consultation under the ESA. In doing so, FERC adopted the SA by reference. FERC provided NOAA Fisheries a draft environmental impact statement (DEIS) for Project relicensing that incorporates the analysis contained in the draft BA and adopted the BA without modification (FERC letter of May 7, 2002) for anadromous species. FERC concluded in its DEIS that relicensing of the Project under the terms of the SA with staff's additional recommended measures may adversely affect Oregon Coast (OC) coho salmon (*Oncorhynchus kisutch*). FERC requested initiation of formal section 7 consultation on this basis.

This biological opinion analyzes the potential effects of the proposed action on threatened OC coho salmon occurring in the North Umpqua River. This biological opinion also considers the effects of the proposed action on designated EFH in the North Umpqua River.

The objective of this biological opinion is to determine whether continued Project operations and associated construction, maintenance, and enhancement actions contained in the SA and described in the DEIS are likely to jeopardize the continued existence of OC coho salmon. As explained below in section 3.2, NOAA Fisheries evaluates the impact of the Project on habitat in its jeopardy analysis.

This biological opinion does not include a critical habitat analysis, because critical habitat designations for this ESU were recently vacated by court order. On February 16, 2000, NOAA Fisheries designated critical habitat for 19 ESUs of chinook, chum, and sockeye salmon as well as steelhead in Washington, Oregon, Idaho, and California. On September 27, 2000, NOAA Fisheries approved Amendment 14 to the Pacific Coast Salmon Fishery Management Plan designating marine and freshwater EFH for Pacific salmon pursuant to the MSA. Shortly after these designations, the National Association of Homebuilders filed a lawsuit challenging the designations on a number of grounds. On April 30, 2002, the United States District Court for the District of Columbia adopted a consent decree resolving the claims in the lawsuit. Pursuant to that consent decree, the court issued an order vacating the critical habitat designations, but retaining the MSA EFH designations. National Association of Homebuilders, et al. v. Evans, Civil Action No. 00-2799 (CKK)(D.D.C., April 30, 2002). Thus, the critical habitat designation for OC coho salmon is no longer in effect. NOAA Fisheries intends to reissue critical habitat designations. Reinitiation of consultation will be required if the proposed action affects critical habitat designated after consultation has been completed (50 CFR §402.16(d)).

An additional objective of this biological opinion is to determine whether the proposed action adequately protects designated EFH. This biological opinion is based on NOAA Fisheries' review of the effects of Project structures and operations on salmonid survival and persistence in the North Umpqua River basin.

This biological opinion addresses the direct and indirect effects of the proposed action, along with effects that are interrelated or interdependent to the proposed action. Included are the effects of interim Project operations and interim conservation measures contained in the SA that are presently being implemented by PacifiCorp prior to the issuance of a new license. Also included are the effects of long-term Project operations and associated SA measures proposed for inclusion in a New License. Consequently, the scope and term of this biological opinion are broad, and include both interim and long-term Project operations and measures contained in the SA and DEIS. Project operations and measures contained in these documents commenced upon the SA's signature in June 2001, and extend for a period of 35 years after license issuance.

1.2 Events Leading Up to This Consultation

After completing the traditional relicensing pre-filing consultation process and filing an application for a new license in 1995, PacifiCorp initiated a collaborative watershed analysis process to address and resolve specific resource concerns that emerged during the traditional relicensing process. Settlement discussions began in 1997 and were ongoing through 1999 between PacifiCorp, state and Federal agencies, and various non-governmental organizations (NGO). During these original discussions, the North Umpqua Resource Management Team was created and issued the *North Umpqua Cooperative Watershed Analysis Synthesis Report*. Negotiations subsequently stalled and PacifiCorp withdrew from the settlement talks.

In June 2000, PacifiCorp, NOAA Fisheries, U.S. Forest Service (USFS), U.S. Bureau of Land Management (BLM), U.S. Fish and Wildlife Service (USFWS), State of Oregon (the State), Oregon Department of Environmental Quality (ODEQ), Oregon Department of Fish and Wildlife (ODFW), Oregon Water Resources Department (OWRD), Douglas County Board of Commissioners, and NGOs (collectively, the Original Parties) reconvened to discuss terms and conditions for the Project's new license. The Original Parties signed an alternative dispute resolution (ADR) agreement in July, 2000, with a goal of completing a settlement agreement by the end of September 2000. Although the Original Parties worked to reach an agreement by that date, they were unable to do so.

The majority of the Original Parties felt that a great deal had been accomplished by their efforts up to that point and expressed a desire to continue working toward a settlement agreement. In October 2000, the remaining parties signed a second ADR agreement with a goal of completing an Agreement in Principle by December 15, 2000. The signatories to the October 2000 ADR were PacifiCorp, USFS, USFWS, BLM, NOAA Fisheries, the State, ODEQ, ODFW, and OWRD (collectively, the Parties).

On November 15, 2000, FERC issued a Notice of Application and Ready for Environmental Analysis requiring that all comments, recommendations, terms and conditions, and prescriptions for the Project be submitted to FERC by March 1, 2001. The governmental parties, including NOAA Fisheries, subsequently filed preliminary terms, conditions, prescriptions, and recommendations with FERC. On June 13, 2001, the Parties entered into a comprehensive settlement agreement for the purpose of resolving all issues related to the relicensing and ongoing operation of the Project. Subsequently, on August 13, 2001, NOAA Fisheries filed revised terms, conditions, and prescriptions consistent with the SA.

On April 30, 2002, FERC issued a DEIS recommending the adoption of the SA into a new Project license, with four modifications. FERC has now initiated formal consultation on proposed license issuance, and has identified the SA and its associated measures as its preferred alternative for purposes of relicensing.

Since execution of the June 13, 2001, SA, the Parties have commenced implementing various sections of this SA. During this process of implementation, the Parties identified new information that warranted revisions to the June 13, 2001, SA. Specifically, under section 8.3 of the SA, approximately 5,000 to 15,000 square ft of spawning habitat was intended to be restored or created in this area. Analysis by PacifiCorp suggests that only about 1,200 to 1,500 square ft of spawning habitat can be restored or created in the Soda Springs bypass reach. Amendment No. 1 to the SA, filed with FERC on November 1, 2002, revises and modifies section 8.3 of the SA, along with related sections 5.1, 7.1, and 7.2. The Parties have revised these SA sections consistent with their original goals and objectives as expressed in the June 13, 2001, SA and related documents. Consequently, this Amendment has modified the proposed action under consultation, and this biological opinion reflects such an amendment.

1.3 Approach

The standards for determining jeopardy are set forth in section 7(a)(2) of the ESA as defined by 50 CFR §402.02 (the consultation regulations). In conducting analyses of habitat-altering actions under section 7 of the ESA, NOAA Fisheries uses the following steps of the consultation regulations combined with the Habitat Approach (NMFS 1999): (1) consider the status and biological requirements of the species; (2) evaluate the relevance of the environmental baseline in the action area to the species' current status; (3) determine the effects of the proposed or continuing action on the species, and whether the action is consistent with the available recovery strategy; (4) consider cumulative effects; and (5) determine whether the species can be expected to survive with an adequate potential for recovery under the effects of the proposed or continuing action, the effects of the environmental baseline, and any cumulative effects, and considering measures for survival and recovery specific to other life stages. If NOAA Fisheries determines that the proposed action is likely to jeopardize, NOAA Fisheries will identify reasonable and prudent alternatives for the action that avoid jeopardy.

Recovery planning will help identify measures to help conserve listed salmonids and increase their survival at each life stage. NOAA Fisheries also intends recovery planning to identify the areas/stocks most critical to species conservation and recovery and to thereby evaluate proposed actions on the basis of their effects on those factors.

Guidance for making determinations on the issue of jeopardy and adverse modification of habitat is contained in a NOAA Fisheries memo entitled "The Habitat Approach: Implementation of Section 7 of the Endangered Species Act for Actions Affecting the Habitat of Pacific Anadromous Salmonids" (NMFS 1999). The Habitat Approach states that biological requirements of listed species (Step 1, above) may be expressed either in terms of population viability (e.g., survival rates, trends in abundance) or as the habitat conditions necessary to ensure the species' continued existence. The Habitat Approach asserts a strong causal link between the habitat condition and population viability. For consultations such as this one, NOAA Fisheries applies the Habitat Approach by evaluating the effects of the action on properly functioning habitat conditions (PFC). This approach is described in more detail in Section 3.2.

For the proposed action, NOAA Fisheries' jeopardy analysis considers the direct and indirect mortality of listed species attributable to the proposed action, and the extent to which the proposed action may impair the function of essential elements necessary for migration and spawning of the listed salmonids under the environmental baseline.

The analysis was based on a review and synthesis of the best available scientific and commercial information. Specific sources are listed in the bibliography and cited throughout the body of the document. Primary sources of information included the application for a new license (PacifiCorp 1995), *North Umpqua Cooperative Watershed Analysis Synthesis Report* (Stillwater Sciences 1998), the *North Umpqua Hydroelectric Project Biological Assessment and Essential Fish Habitat Assessment* (PacifiCorp 2002), and FERC's DEIS for the proposed action (FERC 2002a).

2. PROJECT DESCRIPTION AND ACTION AREA

2.1 Project Description

The Project is located in Douglas County, Oregon, about 100 km (60 mi) east of Roseburg, Oregon. The Project was constructed between 1947 and 1956 near the headwaters of the North Umpqua River. The North Umpqua River originates on the western slope of the central Cascade Range in south-central Oregon and drains about 3,400 km^2 (1,350 mi^2) before it joins with the South Umpqua River to form the mainstem Umpqua River just west of Roseburg. The Project generates hydroelectric power by using water primarily from the North Umpqua River and two of its major tributaries, the Clearwater River and Fish Creek.

With the exception of some transmission facilities, the Project is located entirely within the Umpqua National Forest on lands administered by the USFS. Several state and Federal resource agencies, some with overlapping mandates, are involved in resource management in the Project vicinity. All hydroelectric generation facilities, as well as the eastern portions of transmission lines 39 and 46, are located on lands administered by the USFS. The western portions of the transmission lines, from the Umpqua National Forest west to the town of Dixonville, are located on a patchwork of private and BLM-administered lands.

The 185-megawatt hydroelectric Project comprises eight developments: five dams on the mainstem North Umpqua River (Soda Springs, Slide, Toketee, and Lemolo Nos. 1 and 2), one on Fish Creek, and two on Clearwater River (Clearwater Nos. 1 and 2) (North Umpqua Diversion Development Map). Each Project development typically consists of a dam, waterway, penstock, and powerhouse. The Project has a total waterway length of 60 km (37.3 mi), including 34.9 km (21.7 mi) of canal, 15.8 km (9.8 mi) of flume, and 9.3 km (5.8 mi) of penstock. Three reservoirs (Lemolo, Toketee, and Soda Springs) and four forebays provide limited water storage. Seven of the eight power plants consist of a single outdoor-type generating unit; the Toketee power plant contains three indoor turbine-generators. The locations and configurations of these facilities are discussed in detail in section 2 of the DEIS (FERC 2002a), as well as PacifiCorp's license application (PacifiCorp 1995). These discussions are hereby incorporated by reference. The Project's total nameplate capacity is 185,500 kilowatts (kW). The Project includes 188 km (117.5 mi) of transmission line and 58 km (36 mi) of access roads. It also includes staff housing and related support facilities.

Major Project facilities consist of the following structures:

Soda Springs Dam is a 23.5-m (77-ft) high thin arch reinforced concrete dam. The Soda Springs development is the farthest downstream Project development on the North Umpqua River. The facility consists of (1) a diversion dam on the North Umpqua River about 1.3 miles below the mouth of Slide Creek Reservoir; (2) 2,112 ft of steel pipe flow line; (3) a surge tank; (4) 168 ft of steel penstock; and (5) a powerhouse on the North Umpqua River about 1.5 miles downstream from the mouth of Medicine Creek. Soda Springs Dam is the lowermost Project dam; it presently constitutes a barrier to upstream fish migration, including coho salmon and steelhead.

Fish Creek Dam is a 2-m (6.5-ft) high concrete gravity structure with free crest spillway, with a fish ladder and sluiceway. The Fish Creek development consists of (1) a diversion dam; (2) 25,662 ft of canal and flumes; (3) a 110.3 acre-foot forebay; (4) 2,358 ft of penstock; and (5) a powerhouse on the North Umpqua River between the Toketee powerhouse and the Slide Creek Diversion Dam. Fish Creek is presently inaccessible to anadromous fish as it is upstream from Soda Springs Dam. However, after installation of fish passage at Soda Springs Dam, anadromous fish will be able to access Fish Creek up to the boulder obstacle 3.2 miles upstream of the confluence with the North Umpqua River. Steelhead may be able to pass the obstacle during certain hydrological conditions, and could possibly get as far upstream as the diversion facilities.

Slide Creek Dam is a 9.1-m (30-ft) high concrete gravity structure. The Slide Creek development is located on the North Umpqua River downstream of Toketee Falls, between the Fish Creek powerhouse and the Soda Springs Reservoir. The development consists of (1) a diversion dam located 900 ft downstream from the Toketee powerhouse; (2) 9,653 ft of canal and flumes; (3) 374 ft of penstock, and (4) a powerhouse on the North Umpqua River about 1.3 miles upstream of Soda Springs Dam. Slide Creek Dam is a barrier to upstream fish migration, and thus limits access to 1.4 miles of the North Umpqua River downstream of Toketee Falls, a natural fish barrier.

Toketee Dam is a 17.7-m (58-ft) high earthfill, center clay core structure. The Toketee development, which includes Toketee Lake, is located at the confluence of the Clearwater and North Umpqua rivers. It consists of (1) an embankment dam on the North Umpqua River that impounds the 1,051 acre-foot Toketee Lake; (2) 6,994 ft of pipe and tunnel; (3) a single 1,067-foot-long penstock that near its downstream end splits into three sections, each 158 ft long; and (4) a three unit powerhouse on the North Umpqua River about 2 miles downstream from Toketee Lake and about 1.25 miles downstream from Toketee Falls.

Lemolo No. 2 Dam is 7.6-m (25-ft) high diversion dam consisting of a concrete gravity structure with a free crest spillway topped by flashboards. It consists of (1) a diversion dam about 190 ft downstream of the Lemolo No. 1 powerhouse that impounds a small pond; (2) 69,503 ft of canal and flumes; (3) a 230.6-acre-foot forebay; (4) a 71-foot-high surge tank; and (5) a powerhouse on the North Umpqua River about 3,500 ft upstream of Toketee Lake.

Lemolo No. 1 Dam is a 32.3-m (106-ft) high rockfill structure with upstream concrete facing. The Lemolo No. 1 development is the most upstream development on the North Umpqua River, located about 1 mi downstream from the river's confluence with Lake Creek. The development consists of (1) an 11,752-acre-foot impoundment known as Lemolo Reservoir; (2) 16,310 ft of canal and flumes; (3) 7,338 ft of steel penstock; and (4) a powerhouse on the North Umpqua

River at the mouth of Warm Springs Creek, 4.5 miles downstream from the dam at Lemolo Reservoir.

Clearwater No. 2 Dam is a 5.5-m (18-ft) high concrete buttress on a concrete slab, with a free crest spillway. The Clearwater No. 2 development, downstream from Clearwater No. 1, consists of (1) a diversion dam at the mouth of Mowich Creek that impounds a small reservoir; (2) 31,253 ft of canal and flumes; (3) a 70.7-acre-foot forebay; (4) 1,169 ft of penstock; and (4) a powerhouse on the North Umpqua River at Toketee Lake.

Clearwater No. 1 Dam is a 5.2-m (17-ft) high earthfill structure, with upstream rip-rap face and free crest concrete spillway. The Clearwater No. 1 development is the uppermost development on the Clearwater River, a tributary to the North Umpqua River that has its confluence near Toketee Dam. The development consists of (1) a diversion dam about 8.1 miles upstream of Toketee Lake that impounds Stump Lake; (2) 13,037 ft of canal and flumes; (3) a 120.8-acre-ft forebay; (4) 4,863 ft of penstock; and (5) a powerhouse discharging directly upstream of the Clearwater No. 2 diversion.

Aside from these Project dams, the Project likewise contains a variety of canals, flumes, and penstocks used to convey and divert water. Finally, access to Project facilities is provided by a variety of roads, some of which are used for the sole purpose of Project activities, and some of which are jointly used by PacifiCorp and the USFS.

2.2 Action Area

The Action Area for the proposed action includes all geographic areas directly or indirectly affected by SA measures and Project operations. This area extends from the headwaters of the North Umpqua River downstream through the Wild and Scenic River reach, which terminates at the confluence of the North Umpqua River and Rock Creek. The area includes all tributary watersheds to this reach, down to and including the Rock Creek basin. The area also includes the transmission line corridor that extends westward from the Project to the town of Dixonville, Oregon. The North Umpqua Cooperative Watershed Analysis concluded that the Project did not appear to affect channel characteristics and sediment supply downstream of Rock Creek (Synthesis Report, p. 2-26). Project effects on sediment appear to be imperceptible downstream of the mouth of Steamboat Creek, which is 24 km (15 mi) upstream of the confluence of Rock Creek with the North Umpqua River (Synthesis Report, p. 2-26). Since the late 1980s, the Project has been operated to minimize ramping in the Wild and Scenic River reach (Synthesis Report, p. 4-29) and under the proposed action, Project effects on ramping are expected to be insignificant downstream of the confluence of Rock Creek (Settlement Agreement, Section 6).

2.3 Proposed Action

The proposed action is FERC's issuance of a new license to operate the Project according to the terms of the SA and as described in the DEIS (FERC 2002a) and BA (FERC 2002b). The proposed action is comprised of individual resource Protection Mitigation and Enhancement (PM&E) measures that are identified in these documents and described below, as well as associated Project operations and facilities. The anticipated effects of the proposed action on coho salmon are addressed in Section 4.

Site-specific plans for construction activities that result in ground or habitat disturbance, whether within or outside of water bodies, are to be completed in consultation with NOAA Fisheries (FERC 2002a). To reduce adverse effects associated with construction, proposed plans will include a construction schedule providing for in-river and riparian construction during non-critical periods for affected resources.

Under the proposed action, the Project would operate as described in the recommended staff alternative in the DEIS (FERC 2002a). PacifiCorp would continue to operate Soda Springs Dam as a "re-regulating" facility to capture and regulate water flowing from the Project's upper developments, thus allowing more efficient use of water resources for energy production. Upper Project developments would continue to operate daily during the peak energy period and shut down overnight during the off-peak period. During the off-peak period, water stored in Soda Springs Reservoir would be used to maintain the required flows in the North Umpqua River below the Project. When the upper developments are brought back online during the peak energy period, Soda Springs Reservoir would be refilled. This operational regime will result in daily water level fluctuations in Soda Springs Reservoir.

Below we briefly summarize the proposed Project operations and PM&E measures associated with the proposed action that are reasonably certain to have direct or indirect effects on coho salmon. A more detailed discussion of Project operations and PM&E measures is contained in the DEIS (FERC 2002a) and SA.

2.3.1 Project Facilities and Operations

2.3.1.1 Soda Springs Development

Soda Springs Dam is located on the North Umpqua River, at River Mile (RM) 69.8 on the mainstem North Umpqua River. Under the proposed action, Soda Springs Dam would continue to operate as a re-regulating facility, impounding about 307.4 acre-ft of water in Soda Springs Reservoir, at the normal maximum water surface elevation of 1807.0 ft mean sea level. Water is diverted at Soda Springs Dam through a concrete intake into a waterway consisting of a 2,112-ft-long steel pipe. The waterway discharges to the Soda Springs penstock, which connects to the Soda Springs powerhouse. The Soda Springs powerhouse discharges all of the diverted water to the North Umpqua River at North Umpqua RM 69.3.

As a result of this diversion, the Project creates a 0.5-mile-long bypass reach in the North Umpqua River. The current minimum instream flow for the bypass reach is 25 cfs year-round, except that an additional 8 cfs may be diverted to the ODFW fish-holding ponds located adjacent to the powerhouse. Under the amended proposed action, the minimum instream flows in the bypass reach should be increased to 95 cfs commencing September 1, 2003 and increase to 275 cfs on September 1, 2005.

Ramping rates below Soda Springs Dam are presently limited to 4 inches per hour and a maximum of 12 inches per day. However, PacifiCorp should modify this ramping regime to minimize Project-induced flow fluctuations in the Wild and Scenic River Reach below Soda Springs Dam (subject to a 5% or less variation attributable to equipment limitations) at flows below 1,600 cfs, unless studies of ramping and its effects on stranding habitat demonstrate that some degree of fluctuation would not adversely affect resources (DEIS, Section 2.2.2, p. 2-29 to 2-30). At flows above 1,600 cfs and up to the point where natural flows result in spilling at Soda Springs Dam, Project-induced fluctuations would be restricted to 0.1 foot per hour and 6 inches per day, unless ramping studies show that more fluctuation would not adversely affect resources. PacifiCorp, in consultation with NOAA Fisheries, should conduct a study to evaluate whether agency resource goals can be met under a more flexible ramping regime. No changes would be made to the ramping restrictions given above unless the Parties to the SA accept such changes (DEIS, Section 2.2.2, p. 2-29 to 2-30).

As part of the proposed action, PacifiCorp will ensure that ramping criteria established for the Wild and Scenic River Reach are maintained during emergency shutdowns (DEIS, Section 2.2.2, p. 2-29 to 2-30). PacifiCorp will implement measures necessary to achieve this result, including, but not limited to, installing a new emergency bypass valve at Soda Springs powerhouse, or improving the existing bypass valve (DEIS, Section 2.2.2, p. 2-29 to 2-30). PacifiCorp will complete this action by the time the new license is issued, or by 2004, whichever is earlier (PacifiCorp et al. 2001).

As indicated in Table 2-2 of the DEIS (FERC 2002a), under the proposed action, maximum daily reservoir fluctuations in Soda Springs Reservoir would increase from 4.3 ft to 16.0 ft. Fish ladder and screen designs will accommodate the proposed Project operational regime. Fish ladders and screens will be designed in coordination with NOAA Fisheries and the other resource agencies to ensure such facilities function as intended (DEIS, Section 3.4.2.3, p. 3-94).

Soda Springs Dam is presently a barrier to the upstream migration of fish, including coho salmon. Consequently, Soda Springs Dam blocks access to about 6.6 miles of habitat above the dam, in the North Umpqua River and Fish Creek. Under the proposed action, upstream and downstream fish passage facilities would be constructed at Soda Springs Dam and would be tested and functioning by the seventh anniversary of the new license (DEIS, Section 2.2.2, p. 2-30 to 2-31). This measure would restore anadromous fish access to historically accessible reaches of the mainstem North Umpqua River between Soda Springs Dam and Slide Creek Dam and to the Fish Creek basin.

Under the proposed action, PacifiCorp would provide volitional upstream fish passage at Soda Springs Dam by means of a vertical-slot fish ladder that meets design criteria established by

NOAA Fisheries, USFWS, and ODFW for passage of adult salmonids and lamprey (DEIS, Section 2.2.2, p. 2-30). A fish-counting facility using a video camera and recording system would be installed in the fish ladder (DEIS, Section 2.2.2, p. 2-30). Further, PacifiCorp should modify the Soda Springs Dam spillway by the seventh anniversary of the New License to reduce the potential for outmigration delay and/or injury at this location (DEIS, Section 3.4.2.3, p. 3-94).

Under the proposed action, PacifiCorp should install a downstream fish bypass system (fish screens) at Soda Springs Dam that will achieve the performance standards contained in Appendix B of the SA. PacifiCorp should construct fish screens by the fifth anniversary of the New License to permit adequate testing of screen performance and to ensure adequate screen performance by the seventh anniversary of New License, when upstream fish passage is constructed (DEIS, Section 3.4.2.3, p. 3-95). Downstream passage facilities would be designed to include a trap for evaluating screen performance and to accommodate long-term monitoring of the downstream migrant population as part of the program to evaluate the success of the reintroduction of anadromous fish above Soda Springs Dam.

Under the proposed action, PacifiCorp should install tailrace barriers, designed to prevent salmonids from swimming upstream into the tailrace and being delayed in their migration at Soda Springs powerhouse, by the first anniversary of the New License (DEIS, Section 2.2.2, p. 2-30). PacifiCorp should maintain existing protection measures at these locations until new tailrace barriers are installed. PacifiCorp should design and construct the tailrace barriers in consultation with NOAA Fisheries. Prior to initiation of construction, PacifiCorp should submit tailrace barrier design to NOAA Fisheries for approval (DEIS, Section 3.4.2.3, p. 3-95).

2.3.1.2 Fish Creek Development

Fish Creek Dam is located about 6 miles upstream from Fish Creek's confluence with the North Umpqua River. Fish Creek is presently not accessible to anadromous fish as it is above Soda Springs Dam which is a complete upstream fish migration barrier; however, after installation of fish passage at Soda Springs Dam, steelhead, and possibly coho salmon, may utilize lower areas of Fish Creek.

Fish Creek Dam is 6.5-ft-high, and contains a fish ladder and sluiceway. PacifiCorp should maintain this existing fishway during the period of a new license (DEIS, Section 2.2.2, p. 2-31). The Fish Creek diversion impoundment has no active storage; however, the Fish Creek forebay contains a 9.3 acre impoundment with a total storage 110 acre-ft and an active storage of 83 acre-ft. Water is delivered to the forebay via the development's flume and canal system. The forebay reregulates water from off-peak to peak demand periods. The powerhouse is operated in a daily peaking regime, running at high efficiency during high demand periods and being shut down at night, except during high runoff periods when peak generation prevents water spilling.

Under the existing license, the instream flow required in the bypass reach is 20 cfs from April 1 though Labor Day, and 10 cfs from the day after Labor Day to March 31. The fish ladder is designed to pass 10 cfs through its entrance slot and provides a portion of the instream flow. Under the proposed action, instream flows in the bypass reach would range from 50 to 80 cfs commencing in the first anniversary of a new license, and 130 cfs by the seventh anniversary of a new license (DEIS, Section 3.4.2.1, p. 3-79 to 3-81).

As indicated in Table 2-2 of the DEIS (FERC 2002a), the existing maximum daily water level fluctuations in the Fish Creek forebay are 3.0 ft per day. Under the proposed action, these fluctuations would increase to 6.0 ft per day.

The Fish Creek diversion intake is located northwest of the dam at the end of the impoundment. The intake is a concrete structure with a trashrack and two slide gates. Under the proposed action, PacifiCorp should install a fish screen at the Fish Creek intake by the second anniversary of a new license (DEIS, Section 3.4.2.3, p. 3-96). Screens will be designed in accordance with criteria established in Appendix B of the SA. Further, PacifiCorp should submit written design specifications to NOAA Fisheries for review and approval prior to screen installation (DEIS, Section 3.4.2.3, p. 3-95).

2.3.1.3 Slide Creek Development

The Slide Creek Development has no active diversion reservoir or forebay capacity; however, the dam forms a 2.0 acre-pond with a total storage of 43 acre-ft. Water in this impoundment is diverted to the Slide Creek waterway, which has a capacity of 1,500 cfs. The Slide creek waterway discharges diverted water to the Slide Creek penstock at the Slide Creek forebay. The Slide Creek development operates in a run-of-river mode, following discharges from the upstream Toketee and Fish Creek Developments. Flow through the turbine is continuously adjusted to maintain a set water level in the penstock forebay at the end of the Slide Creek Canal. Flows above the canal's capacity spill over the diversion dam.

The currently required instream flow for the Slide Creek bypass reach is 25 cfs year-round; however, as described in section 2.3.2 below, PacifiCorp should increase this minimum instream flow to 50 cfs by the first anniversary of a new license, and 240 cfs by the seventh anniversary of a new license, when they reach will become accessible to anadromous fish (DEIS, Section 2.2.2, p. 2-25). An opening at the base of flume immediately downstream of the dam releases the instream flow for the bypass reach. The opening is sized to provide instream flow with the reservoir at the lowest operational level. A staff gage is located on the North Umpqua River about 600 ft downstream from the diversion.

Under the proposed action, there would be no restrictions on Project-induced ramping in the Slide Creek full-flow reach until such time as the Parties to the SA agree to such restrictions following studies evaluating effects of ramping in this reach. PacifiCorp, in consultation with ODFW, USFWS, USFS, and NOAA Fisheries, should develop a monitoring and evaluation plan prior to completing construction of fish passage facilities at Soda Springs Dam to determine the effects of current ramping levels and emergency shutdowns on anadromous fish (DEIS, Section 2.2.2, p. 2-30). This monitoring plan will be implemented by the seventh anniversary of the new license (Settlement Agreement, Section 6.2.1). If the Parties determine, based on the results of the monitoring plan, that (1) anadromous salmonids use the Slide Creek full-flow reach for spawning and spawning is adversely affected by ramping, or (2) migratory movement of anadromous salmonids in this reach is adversely affected by the existing ramping regime, PacifiCorp should commence operating the Toketee powerhouse to ensure that generation units are brought into operation individually, in one-hour intervals, to protect against rapid flow fluctuations.

As part of the proposed action, PacifiCorp should evaluate, in consultation with NOAA Fisheries, whether the current bypass flow configuration at Slide Creek powerhouse is sufficient to prevent adverse impacts on aquatic resources during emergency shutdowns by the first anniversary of the new license (DEIS, Section 2.2.2, p. 2-30). If the Settlement Parties determine that such a bypass valve is needed, PacifiCorp should install such a valve or propose alternative mitigation measures to achieve the same result within a time period to be determined through consultation with NOAA Fisheries (DEIS, Section 3.4.2.2, p. 3-90).

Under the proposed action, Slide Creek Dam would remain a barrier to upstream migration of anadromous fish. Anadromous fish habitat upstream of this dam is limited to a 2.2km (1.4 mi) reach downstream of Toketee Falls, which is a large impassable natural barrier to upstream fish movement. PacifiCorp should provide tailrace barriers designed to prevent salmonids from swimming upstream into the tailrace at the Slide Creek powerhouse by the fifth anniversary of the new license (DEIS, Section 3.4.2.3, p. 3-95). PacifiCorp should maintain existing protection measures at these locations until new tailrace barriers are installed. PacifiCorp should design and construct the tailrace barriers in consultation with NOAA Fisheries. Prior to initiation of construction, PacifiCorp should submit designs to NOAA Fisheries for its review approval (DEIS, Section 3.4.2.3, p. 3-95).

Numerous investigations conducted during the relicensing and settlement negotiations support the conclusion that installation of fish passage facilities at Slide Creek Dam is not warranted (FERC 2002a; NMFS 2001 [revised section 18 fishway prescriptions]). The results of these evaluations indicate that providing fish passage at the Slide Creek Dam would provide less benefits to native, wild anadromous salmonids than the alternative mitigation measures described below.

PacifiCorp should undertake a variety of measures to provide a net benefit to wild anadromous salmonids in the basin in lieu of providing fish passage at Slide Creek Dam. The Rock Creek basin was selected as the primary area for off-site, in-vicinity habitat enhancement because (1) it contains alluvial habitat that is relatively rare in the basin and that could provide high quality spawning and rearing habitat for anadromous fish, and (2) it is a high-priority fisheries enhancement area for ODFW. Three mitigation measures are described in the memorandum of understanding (MOU, p.3-98 and 5-6) entered into by PacifiCorp and the Oregon Fish and Wildlife Commission (Section 2.2.2, p. 2-31):

- Upgrading the Rock Creek Diversion Dam fishway to improve upstream passage for migratory fish and to allow for sorting of hatchery from wild fish,
- adding large woody debris (LWD) to East Fork Rock Creek to enhance in-channel habitat for fish, and
- increasing riparian protection through purchase of conservation easements in portions of the Rock Creek basin.

In addition to the mitigation measures included in the MOU between PacifiCorp and the Oregon Fish and Wildlife Commission, the SA includes two other mitigation components for impacts of the Project on anadromous fish: a long-term monitoring and predator control plan for Soda Springs Reservoir, and a Mitigation Fund to be administered by the USFS. Each of the mitigation measures is discussed below.

Upgrading the Rock Creek Diversion Dam to improve fish passage
Under the proposed action, PacifiCorp should provide 50% of the funding for upgrading the Rock Creek Hatchery Diversion Dam as mitigation for waiving the State's requirement for fish passage at the Slide Creek Dam (DEIS, p. 3-97 to 3-101; p. 5-5). The design goal is to achieve 100% upstream and downstream passage for both juvenile and adult fish. The upgrade of the Rock Creek fishway would include a fish sorting facility to monitor adult fish escapement and enable sorting of hatchery from wild fish.

PacifiCorp should monitor the performance of the dam upgrade. Performance evaluations for the dam upgrade would be based on upstream and downstream passage for both juvenile and adult anadromous salmonids. The upgrade would be constructed to meet contemporary ODFW and NOAA Fisheries standards for fish passage (DEIS, p. 3-97 to 3-101; MOU, p. 17). After the upgrade of the diversion dam is complete, an analysis would be conducted on fish passage at the facility.

Implementation of fish passage measures should be accompanied by detailed plans for monitoring the effectiveness of these measures. These plans should include goals and objectives for the mitigation, as well as detailed performance criteria (DEIS, p. 3-101). The monitoring may include direct observations of fish in the vicinity of the dam, as well as modeling of passage efficiency under a variety of expected flow conditions. If the performance-based thresholds detailed above are not achieved within 2 years of the diversion dam upgrade, PacifiCorp and ODFW should perform an analysis to determine the reason for lack of passage efficiency (DEIS, p. 3-97 to 3-101; MOU, p. 17).

Large woody debris enhancement in East Fork Rock Creek
LWD enhancement efforts would be located within the current distribution of coho salmon

where temperatures are currently suitable for coho salmon growth and survival (DEIS, p. 3-97 to 3-101). PacifiCorp should:

- Implement monitoring to ensure that LWD additions are appropriately placed to improve habitat;
- maintain at least 130 pieces of LWD that potentially contribute to habitat for anadromous fish, using guidelines developed jointly by ODFW and PacifiCorp, throughout the duration of the new FERC license (if this performance standard is not met, PacifiCorp should add additional LWD or move previously placed LWD to meet the standard);
- contribute at least $600,000 towards LWD enhancements; and
- fund (in addition to the $600,000 for enhancement measures) and conduct a monitoring study to (1) identify the density of LWD loading and the configuration of LWD placements that provide the greatest benefits to anadromous fish for a given cost and (2) determine the amount of increase in coho salmon overwintering carrying capacity that the LWD enhancement measures can accomplish.

Riparian conservation easements in Rock Creek basin

Riparian conservation easements would be implemented in the Rock Creek basin to increase riparian protection in the long term through purchase of conservation easements on private timberlands to protect these areas in perpetuity (DEIS, p. 3-97 to 3-101). Riparian conservation easements would be designed to increase stream channel shading and reduce temperatures in mainstem Rock Creek and certain tributaries. Easement purchases would be based on compensation to private landowners for habitat protection measures that would not already be required under state and Federal regulations. PacifiCorp should conduct effectiveness monitoring of riparian buffers in the Rock Creek basin. Studies of the influence of riparian buffers on stream channels would consist of monitoring stream temperatures prior to and subsequent to protection of riparian buffers, as well as long-term LWD surveys to monitor the recruitment of LWD to reaches adjacent to these buffers. PacifiCorp should monitor the conservation easements to ensure that landowners are managing the land in strict accordance with the terms of the easement.

Monitoring and predator control

PacifiCorp should fund a long-term monitoring and predation control to (1) formulate and implement a study plan, implementation plan, and monitoring and adaptive management plan concerning the potential predation of anadromous salmonid juveniles by nonnative predator species in Soda Springs Reservoir; and (2) monitor and evaluate the success of the reintroduction of anadromous fish populations in the North Umpqua River upstream of the Soda Springs Dam (DEIS, p. 3-97 to 3-101).

Funding for mitigation projects

PacifiCorp should establish a mitigation fund to implement mitigation and enhancement measures on National Forest System lands and BLM-administered lands within the North Umpqua basin (DEIS, p. 3-97 to 3-101). Upon the new license becoming final or 2004, whichever is earlier, PacifiCorp should make annual payments of $250,000 on or before each January 31 throughout the full term of the New License. In addition, PacifiCorp should make a total payment of $8 million to be paid in increments of $1 million commencing on the first January 31 after the New License becomes final or January 31, 2004, whichever is earlier, and on the 2nd, 7th, 10th, 13th, 16th, 19th, and 22nd anniversaries of the first payment.

This fund would be used to enhance and improve wetland and stillwater amphibian habitats, riparian and aquatic species connectivity, vegetation management, terrestrial species connectivity, and to reduce soil loss and soil productivity resulting from erosion. The projects may include stream or riparian enhancement, road decommissioning, or other measures to benefit aquatic and terrestrial species and habitats. When deciding how the funds would be expended to address these impacts, the USFS will consult with the Parties to the SA, fully engage the public, and fully consider all public comment throughout the NEPA environmental analysis process for each undertaking.

2.3.1.4 Project Developments Upstream of Slide Creek Dam

As described above, under the proposed action, areas above Slide Creek Dam would remain inaccessible to anadromous fish, including coho salmon. Historically, some anadromous fish may have occurred as far upriver in the North Umpqua River as Toketee Falls. However, it is unlikely that coho salmon occurred this far upstream.

Developments occurring above Slide Creek Dam include the Toketee, Clearwater Nos. 1 and 2, and Lemolo Nos. 1 and 2 developments. A description of the proposed operations of these Project developments is presented in sections 2 and 3 of the DEIS (FERC 2002a). Further, table 2-2 of the DEIS (FERC 2002a) indicates the existing and proposed maximum daily fluctuations of reservoir and forebay levels associated with these developments.

2.3.2 Flows in Bypass Reaches

2.3.2.1 Minimum Instream Flows

Under the proposed action, PacifiCorp should implement minimum instream flow regimes for the North Umpqua River bypass reaches as shown in Tables 1 and 2 below. PacifiCorp should implement the flow schedule presented in Table 1 by the first anniversary of the New License or by 2005, whichever is earlier (DEIS, Section 2.2.2, p. 2-26). PacifiCorp should implement Table 2 flows by the seventh anniversary of the New License (DEIS, Section 2.2.2, p. 2-26).

PacifiCorp should implement Table 2 flows for Soda Springs bypass reach in 2003, upon completion of the Soda Springs bypass alluvial enhancement project (DEIS, Section 2.2.2, p. 2-26).

Table 1. Pre-anadromous-fish-passage flows (cubic ft per second).

Month	Lemolo 1	Lemolo 2	Clearwater 1	Clearwater 2	Toketee	Slide Creek	Soda Springs	Fish Creek
January	50	50	40	40	60	50	275	50
February	50	50	40	40	60	50	275	50
March	50	50	40	40	60	50	275	50
April	60	60	60	60	60	50	275	50
May	70	70	60	60	60	80	275	50
June	80	70	60	60	80	80	275	80
July	80	80	40	40	80	80	275	80
August	80	80	40	40	80	80	275	80
September	80	80	40	40	80	80	275	80
October	80	80	40	40	80	80	275	80
November	50	50	40	40	60	50	275	50
December	50	50	40	40	60	50	275	50

Table 2. Post-anadromous-fish-passage flows (cubic ft per second).

Month	Lemolo 1	Lemolo 2	Clearwater 1	Clearwater 2	Toketee	Slide Creek	Soda Springs	Fish Creek
January	50	50	40	40	60	240	275	130
February	50	50	40	40	60	240	275	130
March	50	50	40	40	60	240	275	130
April	60	60	60	60	60	240	275	130
May	70	70	60	60	60	240	275	130
June	80	70	60	60	80	240	275	130
July	80	80	40	40	80	240	275	130
August	80	80	40	40	80	240	275	130
September	80	80	40	40	80	240	275	130
October	80	80	40	40	80	240	275	130
November	50	50	40	40	60	240	275	130
December	50	50	40	40	60	240	275	130

2.3.2.2 Instream Flow Monitoring

Under the proposed action, PacifiCorp should install and maintain gage stations at the head of the bypass reaches or elsewhere as required by the OWRD by the date the new license becomes final or by 2002, whichever is earlier (DEIS, Section 2.2.2, p. 2-29). These gages would be used to monitor compliance with the instream flow regimes specified in the SA. PacifiCorp should develop, in consultation with the USFS, NOAA Fisheries, USFWS, ODFW, ODEQ, and OWRD, a coordinated gage installation and data reporting plan (DEIS, Section 2.2.2, p. 2-29).

2.3.2.3 Restrictions on Flow Fluctuations

After the first anniversary of the New License, PacifiCorp should eliminate all ramping in the eight bypass reaches, except during planned maintenance and emergency shutdowns (DEIS, Section 2.2.2, p. 2-29). Fluctuations during these activities should be limited to minimize any impacts on fish or other aquatic resources. For the protection of salmonids in bypass reaches, PacifiCorp should adhere to the following ramping regime during maintenance and emergency shutdowns:

- If salmon fry less than or equal to 60 mm (2.4 in) in length are present (approximately March 1 through June 30), no ramping shall occur during daylight hours (one hour before sunrise to one hour after sunset) and ramping shall not exceed 0.6 m/hr (0.2 ft/hr) during night hours.
- If salmon fry are not present, but fry of resident trout or steelhead are present (approximately May 1 through August 31 for steelhead and June 1 through September 30 for trout), ramping shall not exceed 0.6 m/hr (0.2 ft/hr) during daylight hours and 0.6 m/hr (0.2 ft/hr) during night hours.
- If neither fry of salmon, resident trout, or steelhead are present (approximately October 1 through February 28), down-ramping shall not exceed 0.6 m/hr (0.2 ft/hr) and upramping shall not exceed 0.2 m/hr (0.5 ft/hr) (Settlement Agreement at Section 6.6).

In addition to these criteria, PacifiCorp should minimize impacts in bypass reaches by attempting to release high flows to coincide with the high-flow period of the natural hydrograph and planning maintenance to prevent water-quality standard violations. A table of preferred timing for annual facilities maintenance in Project bypass reaches was developed with the aid of NOAA Fisheries (Settlement Agreement, App. D). The SA requires PacifiCorp to adhere to these ramping limitations and attempt to schedule maintenance actions during natural high-flow periods (SA, Section 6.6). The SA further states that this regime may only be modified by written agreement of the Parties, including NOAA Fisheries (Section 6.6.e.).

2.3.3 Habitat Restoration and Enhancement

As part of the proposed action, PacifiCorp should implement a variety of habitat enhancement actions to mitigate for ongoing habitat impacts associated with Project operations. Such measures include the following:

Continue spawning gravel augmentation below Soda Springs Dam, and augment gravel in the North Umpqua River below Soda Springs Dam

PacifiCorp should continue the ongoing gravel augmentation program below Soda Springs Dam until completion of the North Umpqua River Habitat Creation Project (DEIS Section 2.2.2, p. 2-28). PacifiCorp should provide up to 306 m^3 (400 yd^3) of gravel annually at a cost of up to \$5,000 per year until the completion of the enhancement project. Further, PacifiCorp should fund continuing gravel augmentation below Soda Springs Dam during the term of the license in an amount not to exceed $227,500.

Pass LWD over Project dams

PacifiCorp should continue its current practice of providing for passage of woody debris that enter Soda Springs and Slide Creek reservoirs past Soda Springs and Slide Creek dams using existing facilities (DEIS, Section 3.4.2.4, p. 3-103). By the time the New License becomes final, or 2004, whichever is earliest, PacifiCorp should develop, in consultation with the USFS, ODEQ, NOAA Fisheries, USFWS, and ODFW, an operations plan for passing woody debris past Soda Springs and Slide Creek dams without modification of existing facilities. The operations plan will address the timing, size, and amount of woody debris passed.

Pass sediment past Slide Creek Dam

Commencing upon the Effective Date, PacifiCorp, in consultation with the USFS, USFWS, ODEQ, and ODFW, will provide passage of sediment past Slide Creek Dam using existing facilities (opening floodgates during periods of high flow) (DEIS, Section 3.4.2.4, p. 3-103). PacifiCorp should coordinate sediment passage with restoration projects occurring downstream from Slide Creek Dam to ensure such projects realize anticipated benefits.

Reconnect numerous tributaries and drainages along the canal and flume systems

Under the proposed action, PacifiCorp should reconnect over 50 tributaries and drainages that are presently intercepted by Project features (DEIS, Section 2.2.2, p. 2-33).

Replace and upgrade culverts to accommodate 100-year flood events

PacifiCorp should, in consultation with the USFS, BLM, and ODFW, complete an inventory of culverts on Project lands (DEIS, Section 2.2.2, p. 2-33). The inventory will indicate which culverts require modifications to allow fish passage and which culverts require modifications to pass a 100-year flood. For culverts requiring modifications for fish passage barriers, PacifiCorp should upgrade such culverts commencing after the new license becomes final at a rate of about 20% of such culverts a year, to be completed by the fifth anniversary of the new license (DEIS, Section 2.2.2, p. 2-33). Improvements for fish passage will meet ODFW's fish passage standards for culverts. Inventoried culverts requiring upgrading to accommodate a 100-year flood would be upgraded by the eleventh anniversary of a New License at an average rate of about 7.5% of such culverts per year (DEIS, Section 2.2.2, p. 2-33).

PacifiCorp should replace or remove inadequately sized culverts under roads and along or adjacent to Project waterways associated with Priority 1 and Priority 2 aquatic sites as identified in Schedule 10.6 of the SA. Timing and site-specific plans for culvert removal and replacement would be included in the Transportation Management Plan. In the case of culverts associated with aquatic site reconnections, removal of culverts and replacement with road fords or driveable dips will be installed where feasible. If a road ford may increase an erosion hazard or a hazard to personnel, culverts will be installed that are sufficient to accommodate a 100-year flood, including associated bed load and debris, and to provide riparian and aquatic species connectivity (DEIS, Section 2.2.2, p. 2-33).

Decommission unneeded roads

In cooperation with the USFS, PacifiCorp has identified access roads in need of decommissioning. The listed road segments, totaling 14 km (8.6 mi) of road, should be decommissioned by PacifiCorp according to the guidance in the USFS Manual and Handbook and will be completed by the fourth anniversary of the new license (DEIS, Section 3.10.2.1, p. 3-212). Any road that PacifiCorp determines is no longer needed for Project operation by PacifiCorp will be decommissioned as soon as is practicable according to the same standards.

Mainstem North Umpqua River anadromous fish spawning habitat enhancement

The presence of Project dams and other features affects channel conditions and anadromous fish habitat in the mainstem North Umpqua River. Soda Springs Dam restricts bed load transport to reaches downstream, reducing potential spawning gravel and inundating riverine habitat in reaches upstream. As part of the proposed action, PacifiCorp should (1) maximize usable spawning habitat for anadromous fish, with a priority on spring chinook salmon spawning, given the natural constraints of the river channels and fish barriers; and (2) mitigate for the continued inundation of pre-Project anadromous habitat under Soda Springs Reservoir and habitat lost due to construction of Soda Springs Dam. We discuss these proposed actions below.

North Umpqua River spawning habitat enhancement

Under the amended proposed action, PacifiCorp should provide $410,000 for the restoration of spawning habitat in the North Umpqua River, below Soda Springs Dam. PacifiCorp should prepare a study plan, implementation plan, and monitoring plan concerning the enhancement of anadromous salmonid spawning habitat below Soda Springs Dam. PacifiCorp should prepare these plans in consultation with the USFS, ODFW, USFWS, and NOAA Fisheries and will obtain agency approvals before finalizing the plan. Additionally, PacifiCorp should provide gravel augmentation in coordination with this habitat enhancement project after consulting with the USFS, ODEQ, NOAA Fisheries, USFWS, and ODFW regarding the quantity, quality, and timing of the gravel augmentation.

North Umpqua River gravel augmentation program

Under the amended proposed action, PacifiCorp should provide $227,500 for ongoing gravel augmentation in the North Umpqua River, below Soda Springs Dam to address the geomorphic effects of reduced sediment load below Soda Springs Dam. PacifiCorp should prepare an implementation plan and monitoring plan for this program in consultation with the USFS, ODFW, USFWS, and NOAA Fisheries and will obtain agency approvals before finalizing the plan.

Slide Creek bypass reach spawning habitat enhancement

Under the proposed action, PacifiCorp should enhance spawning habitat in the area from Slide Creek powerhouse upstream to the confluence of Fish Creek by placing new boulders or repositioning existing boulders to trap bedload mobilized by Fish Creek (DEIS, Section 3.4.2.5, p. 3-105). Commencing in June, 2001, PacifiCorp should commence preparing a study plan, implementation plan, and monitoring plan concerning the enhancement of spawning habitat in this area. PacifiCorp should prepare the plans in consultation with the USFS, ODFW, USFWS, and NOAA Fisheries and will obtain agency approvals before finalizing the plans.

The implementation plan will include plans for initial placement of boulders, which would be monitored, and will also include plans for the placement of the rest of the boulders, the methodology for which may be modified based on the results of the initial test placement. PacifiCorp should, in consultation with the agencies, conduct a baseline spawning habitat survey of this area under existing flow and channel conditions. Data from the baseline survey would be used to evaluate the success of the enhancement measure once it is implemented. Upon final placement of boulders, PacifiCorp should implement the monitoring plan to assess whether the expected quantity and quality of spawning habitat are being created as a result of the placement of boulders. Evaluation of the quality and quantity of spawning habitat will include habitat characteristics such as patch area, patch depth, spawning gravel substrate size, amount of fine sediment, and appropriate hydraulic conditions such as intergravel flow to provide adequate dissolved oxygen to salmonid eggs.

Commencing in 2002, PacifiCorp should, in consultation with the agencies, commence initial test placements of boulders to evaluate how gravel deposits are affected by different sizes and configurations of boulder placements under the full range of existing flow regimes to develop design standards that are consistent with instream flows (DEIS, Section 3.4.2.5, p. 3-105). Information obtained from this effort may be used in modifying the implementation plan as appropriate. PacifiCorp should then proceed with final placement of remaining boulders and complete implementation of this measure by the first anniversary of the New License or 2005, whichever is earlier (DEIS, Section 3.4.2.5, p. 3-106).

Erosion and sediment control

Project operations may contribute to soil erosion as a result of reservoir fluctuations, or canal and flume failures. To address the Project's effects on erosion, PacifiCorp should undertake the following:

- Implement a waterway shutoff and drainage system to reduce excess erosion from occurring in the event of a waterway failure, along with an aggressive response in the event of such a failure or a tripping of the system (DEIS, Section 3.2.2.1, p. 3-18).
- Implement remedial measures for all Erosion Sites with a rating of 3 or higher (Medium and High Priority) as identified in the Erosion Control Additional Information Request (DEIS, Section 3.2.2.1, p. 3-18).
- Conduct a monitoring and adaptive management program to address erosion and sediment control over time (DEIS, Section 3.2.2.1, p. 3-21; DEIS, Section 3.2.2.1, p. 3-101-102).

The general programs listed above would include specific measures to address erosion control along the Project's waterways, such as (1) removing sidecasted soil, (2) installing drainage pipes at stream crossings, and (3) installing large-diameter culverts beneath access road embankments.

Since site-specific remediation is proposed, the actual treatment option to be employed would be determined for each site on a least-cost, fit-to-site basis to meet soil productivity standards in the Umpqua National Forest Plan.

3. ENVIRONMENTAL BASELINE AND STATUS OF THE SPECIES

This section describes the environmental baseline conditions in the Action Area. The environmental baseline is the current status of the species and their habitat. It reflects the effects of past and present impacts of all Federal, state, or private actions and other human activities in the Action Area leading to the current status of the species, their habitat, and the ecosystems within the Action Area.

3.1 Federally Listed, Proposed, and Candidate Anadromous Salmonids Occurring in the Action Area

Project facilities and operations in the North Umpqua River basin potentially affect two evolutionarily significant units (ESUs) of anadromous salmonids that are listed or candidates for listing under the Federal ESA (Table 3). Listed or candidate salmonid ESUs that occur in the basin include OC coho salmon (threatened) and OC steelhead (candidate). Consultation is only required for listed and proposed species; therefore, the candidate species will not be addressed further in this biological opinion. OC coastal cutthroat trout also occur in the basin. This species is currently under the jurisdiction of the U. S. Fish and Wildlife Service and will not be addressed in this biological opinion.

Table 3. Listed and candidate species occurring in the Action Area.

Species	ESU	Federal Status	Comments
coho salmon *Oncorhynchus kisutch*	Oregon Coast: The range of the ESU extends from south of the Columbia River to Cape Blanco.	Threatened	Oregon Coast coho salmon were listed as threatened in 1999 (NMFS 1999). In September 2001, a Federal court determined that NOAA Fisheries' 1998 decision to list coho within the Oregon Coast ESU as threatened was unlawful (Alsea Valley Alliance v. Evans, 261 F.Supp.2d 1154 (D. Ore. 2001). The 9th Circuit Court granted a stay of the Alsea Valley Alliance order, in order to leave the ESA listing in effect pending appeal.
steelhead *Oncorhynchus mykiss*	Oregon Coast: The ESU includes steelhead from Oregon coastal rivers between the Columbia River and Cape Blanco.	Candidate	Listing includes both summer and winter steelhead in the North Umpqua River. In March 1998, NOAA Fisheries determined that listing of this ESU as threatened or endangered was not warranted (NMFS 1998a). NOAA Fisheries remained concerned with the status of this ESU, however, and will evaluate the status within 4 years.

3.2 Status and Critical Habitat of Listed and Proposed Anadromous Salmonids

In this section, the status and critical habitat of coho salmon is described. More detailed information on the distribution, population trends, life history, habitat requirements, ecological interactions, and sensitivity to anthropogenic disturbances of coho salmon may be found in Attachment 1 of the Biological Assessment (PacifiCorp 2002).

Biological Requirements

The first step NOAA Fisheries uses when applying the ESA section 7(a)(2) to the listed ESUs considered in this biological opinion is to define the species' biological requirements (Section 1.3). Biological requirements within the action area are a subset of the range-wide biological requirements of the ESU. Identification of the range-wide biological requirements provides context for subsequent evaluation of action area biological requirements.

Relevant biological requirements are those necessary for the listed ESUs to survive and recover to naturally reproducing population sizes at which protection under the ESA would become unnecessary. This will occur when populations are large enough to safeguard the genetic diversity of the listed ESUs, enhance their capacity to adapt to various environmental conditions, and allow them to become self-sustaining in the natural environment. McElhaney et al. (2000) describe the biological requirements of salmonid populations, which are the components of ESUs, as adequate abundance, productivity (population growth rate), spatial scale, and diversity. These attributes are influenced by survival, behavior, and experiences throughout the entire life cycle.

NOAA Fisheries has not yet identified populations within the OC coho salmon ESU, and has not identified a target abundance level or other viability requirements for chinook salmon that spawn in the Umpqua River.

For the ESU to survive and recover, adequate habitat and life-stage specific survival rates must occur within the action area. As described in NMFS (1999; “Habitat Approach”), there is a strong causal link between habitat modification and the response of salmonid populations. Those links are often difficult to quantify. In many cases NOAA Fisheries must describe biological requirements in terms of habitat conditions in order to infer the populations’ response to the effects of the action. To survive and recover, a wide-ranging salmonid ESU must have adequate habitat available for each life history stage.

For this consultation, the relevant biological requirements are important habitat elements that function to support successful adult and juvenile migration, adult holding, spawning, incubation, rearing, and growth and development to the smolt stage. These important habitat elements for OC coho salmon are: (1) Substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food (juvenile only), (8) riparian vegetation, (9) space, and (10) safe passage conditions. The Project activities are likely to affect each of these habitat elements. The majority of these important habitat elements are included in an analysis framework called *Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale* (hereafter referred to as the “matrix”) for making effects determinations at the watershed scale (NMFS 1996). NOAA Fisheries uses the matrix to evaluate the environmental baseline condition (Section 3.2), and effects of the action on important habitat elements for affected OC coho salmon (Section 4).

3.2.1 Coho Salmon

Status, critical habitat, and factors for decline

Coho salmon spawning in the Umpqua River belong to the Oregon Coast ESU, which is listed as threatened (NMFS 1998b). Natural production of coho salmon in this ESU may currently be less than 5% of what it was in the early 1900s (NMFS 1995). Extinctions of coho stocks have occurred primarily in inland areas of their distribution, east of the Coast Range (Botkin et al. 1995). The Umpqua River differs from other coastal basins in Oregon in that it runs through the Coast Range and has its headwaters in the Cascades. Coho salmon spawning in some North Umpqua River tributaries thus have a much longer migration (~320 km [~200 mi]) than those in most other Oregon populations (Kostow 1995). Coho salmon populations in the Umpqua, Coos, and Coquille river basins of the ESU are considered by NMFS (1998b) to be “relatively abundant.”

Because other stocks in the ESU may be at greater risk of local extinction, protection of these larger populations is important for ensuring that there are sources of fish that can recolonize other streams in the ESU through straying. It is important that such fish be as similar as possible to the stocks that currently inhabit these other streams within the ESU in terms of genetic background and life history traits so that they are already well-adapted to the region’s climatic and geologic characteristics.

NMFS (1997) has identified the following activities as responsible for the decline of coho salmon in Oregon:

- logging
- road building
- grazing and mining activities
- urbanization
- stream channelization
- dams (depletion and storage of natural flows; blocked habitat)
- wetland loss from beaver trapping
- water withdrawals and unscreened diversions for irrigation

Abundance and distribution in the Action Area

Adult coho salmon have been counted at Winchester Dam since 1946. Wild coho escapement has averaged 1,100 fish over both the previous 50- and 15-year periods, with lows of about 10 fish occurring in 1983 and 1984 (likely reflecting El Niño effects) and a high of 3,100 fish in 1952. Coho populations declined from an average of 1,800 between 1946 and 1956 to an average of 400 between 1970 and 1980, but numbers have rebounded slightly since then (Pacificorp 2002). Low coho populations in the 1970s may reflect timber harvest impacts and overfishing, both of which were marked during this period, while more recent increases may reflect reduced ocean harvest, natural production of hatchery coho, recovery of degraded riparian and stream habitats, or improved ocean conditions.

Nickelson (2001) estimated 1990-2000 numbers of wild adult coho salmon in the Umpqua basin from the combination of Winchester Dam counts and spawner surveys. Using the habitat-based population viability method developed for other Oregon coho populations by Nickelson and Lawson (1998), he determined that the critical population level for this complex is 4,900 spawners and that available habitat is sufficient to support a viable population. He also estimated adult-to-adult returns for seven brood years during this period and determined that returns averaged 2.1 recruits-per-spawner. However, three of the seven cohorts produced less than one recruit-per-spawner, so the average was dependent upon very high production in a little over half of the brood years.

In the North Umpqua River basin, coho salmon are known to spawn and rear primarily in the lower-gradient reaches of tributaries downstream of Soda Springs Dam. Cavitt Creek, a tributary of Little River, is reported as being one of the largest producers of coho salmon in the basin. A 1972 report estimated that over half of the coho salmon in the North Umpqua basin used the Little River basin for spawning (Lauman et al. 1972). Coho have also been recorded in Rock, Williams, Calf, and Copeland creeks, near the confluence of Steamboat and Canton creeks, and in the mainstem North Umpqua River (Dambacher 1991; PacifiCorp 1995; USFS et al. 1992) (Pacificorp 2002).

In recent years, coho salmon have been observed spawning in the mainstem North Umpqua River in the vicinity of Brit Creek (downstream of Rock Creek confluence and the Action Area) and on the Apple Creek bar (upstream of Steamboat Creek confluence and within the Action Area) (R. Grost, pers. comm., 2001). Coho salmon fry and juveniles are regularly observed in small numbers in suitable habitat that exists in the mainstem, such as the side channel at Island Campground (upstream of Steamboat Creek confluence) (R. Grost, pers. comm., 2001). In years when winter flows are low, access to tributary streams may be reduced; coho salmon may spawn to a greater extent in the mainstem in these years (R. Grost, pers. comm., 2001). Small numbers of coho salmon fry also move downstream out of tributary spawning streams and into the mainstem North Umpqua River every spring, as evidenced by capture in outmigrant traps in Calf Creek (~1 mi upstream of confluence with mainstem) and Boulder Creek (~100 m upstream of confluence with mainstem).

Life history characteristics

After attaining sexual maturity in the marine environment, adult coho migrate to the vicinity of their natal stream during late summer and fall (Sandercock 1991). North Umpqua River basin coho return to freshwater from October to December and spawning occurs from late October to January (Table 4) (USFS et al. 1992; ODFW life history table, unpublished). A recent five-year average fecundity for coho returning the Rock Creek hatchery on the North Umpqua River was 2,138.

Following deposition in the gravel, coho salmon eggs generally incubate for 35–50 days at temperatures of about 9° to 11°C (48.2° to 51.8°F) (Shapovalov and Taft 1954), with incubation time being inversely related to water temperature. In the North Umpqua River basin, coho salmon eggs remain in spawning gravels from mid-October to mid-April; emergence occurs by the end of April (Table 4) (ODFW 2000). After hatching, salmon larvae (alevins) remain in the gravel while undergoing further development and absorption of the yolk sac. Upon emergence from the gravels, coho fry seek low velocity areas along shallow stream margins (Shapovalov and Taft 1954). As they grow, juvenile coho move to deeper habitats, although they continue to prefer low-velocity habitat throughout the rearing period. Following winter peak flows, juvenile coho salmon emerge from winter hiding areas and feed heavily to grow in size in preparation for downstream migration. Coho smolt outmigration generally occurs in the spring. After reaching the estuary, coho salmon may remain for a few months of residency prior to entering the ocean environment. Coho salmon generally remain in the ocean to feed and mature for about 16 months before returning to the freshwater environment to spawn.

Table 4. Life history timing of coho salmon in the North Umpqua River, Oregon (ODFW 2000).

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Adult Migration												
Spawning												
Incubation												
Emergence												
Rearing												

Span of Life History Activity

Existing factors affecting the species in the action area

The depressed state of wild coho populations in the North Umpqua River basin is likely due to a number of factors. Coho salmon tend to spawn and rear in the lower-gradient portions of tributaries and in lower-elevation tributary basins. Throughout the species' range, these areas have often experienced a larger degree of disturbance related to timber harvest, valley-bottom road construction, and, perhaps most importantly, removal of LWD from stream channels. In the North Umpqua River basin, most of the coho salmon population spawns and rears in the lower-gradient reaches of tributaries downstream of Soda Springs Dam (see "Abundance and distribution in the Action Area" above). Coho are thought to be the anadromous salmonid species most reliant on pools for both summer and winter rearing, and removal and reduced recruitment of LWD has likely reduced pool area and quality in many reaches of North Umpqua River basin tributaries. Coho salmon spawning and rearing in North Umpqua basin tributaries may also have been affected by increased water temperatures and increased fine sediment input (see discussions below) in some areas.

Coho salmon populations are generally believed to be limited by density-dependent mechanisms related to the availability of suitable fresh water rearing habitat (Allen 1969; McFadden 1969; Meehan and Bjornn 1991). Degradation of summer and winter rearing habitat in North Umpqua River basin tributaries is likely a major reason for the decline of this species in the North Umpqua River basin. High rates of ocean harvest in the 1960s and 1970s (Kostow 1995) also likely contributed to the decline in coho populations in the 1970s. These and other factors that may be limiting to coho populations are reviewed below.

LWD reductions
Removal of LWD as a result of logging practices and road building and corresponding reductions in pool quality and quantity in North Umpqua River basin tributaries has likely reduced overwintering habitat quality and quantity for coho salmon and been an important factor limiting their populations. Many studies have documented reductions in rearing habitat and low juvenile overwintering coho abundance as a result of the removal of LWD (Tschaplinski and Hartman 1983; Bisson and Sedell 1984; Koski et al. 1984; House and Boehne 1987). Whereas spring chinook and steelhead are able to use coarse rocky substrate as cover, which is abundant in the North Umpqua River basin, coho are highly dependent on LWD and have likely been particularly affected by its removal.

Because juvenile coho show narrower preferences for pool habitat types in the winter than in the summer, habitat limitations may be more common in the winter. Lack of suitable winter habitat may result in poor survival, and many studies indicate that availability of winter habitat may be the ultimate factor limiting coho populations in some parts of their range (Chapman 1966; Chapman and Knudsen 1980; McMahon 1983; Nickelson et al. 1992). Tschaplinski and Hartman (1983) documented decreases in juvenile coho salmon numbers in fall and winter, particularly in response to seasonal freshets. They found that habitats such as deep pools, logjams, and undercut banks with woody debris lost fewer fish during high-flow events and maintained higher juvenile populations over the winter. Rodgers (1986, as cited by House et al. 1991) found only 9% of the juvenile coho found during the summer remaining as smolts in Knowles Creek, a stream system that lacked good overwintering habitat.

Spawning gravel reductions
In the mainstem North Umpqua River, sediment capture by Soda Springs Dam has reduced availability of anadromous salmonid spawning gravels, particularly in the reach from Soda Springs Dam to Boulder Creek, where bedload supply has decreased by 95-100% (Synthesis Report, p. 7-14). Increased sediment delivery from tributaries downstream of Soda Springs Dam as a result of land management- and road-related increases in erosion at least partially compensates for this sediment capture. Cumulative reduction in bedload compared to pre-dam conditions is estimated to be about 15% where the North Umpqua River reaches Steamboat Creek, and below the mouth of Steamboat Creek, bedload has increased from historical amounts

(Synthesis Report, p. 7-15). Comparison of 1946 (pre-dam) and 1992 aerial photographs indicates that there has been little change in the size and location of alluvial features in the reach from Soda Springs Dam downstream to Steamboat Creek, although these features have likely coarsened. Some alluvial features below Steamboat Creek have increased in size, reflecting increased sediment delivery from the Steamboat Creek basin (Synthesis Report, p. 7-15). Because relatively few coho salmon are believed to spawn in the mainstem North Umpqua River and because the area of spawning habitat that has been affected by the Project is small, the effects of sediment reduction by the Project on coho salmon are likely to be small.

Increased water temperatures
Some tributaries used by coho salmon in the North Umpqua basin may experience high water temperatures during the summer low flow season that limit their suitability as coho rearing habitat. Some streams, such as Steamboat Creek, may have historically had high summer water temperatures because of their naturally wide channels and bedrock substrates (Holaday 1992), while others appear to have been affected by reductions in riparian vegetation due to flooding (especially the 1964 flood), debris torrenting, and timber harvesting (riparian buffer strips began to be used in the mid-1970s) (Holaday 1992). Little River, Rock Creek, and Steamboat Creek, which historically provided important tributary habitat for coho salmon, are among the warmest subbasins in the North Umpqua River watershed (Synthesis Report, p. 7-24). A 1972 report estimated that over half of the coho salmon in the North Umpqua basin used the Little River basin for spawning (Lauman et al. 1972). These temperature increases may have reduced summer rearing habitat for juvenile coho salmon and may have contribued to the decline of coho populations in the basin. Increases in water temperature have been documented to result in faster development and earlier emergence of coho, resulting in increased susceptibility to displacement by spring freshets (Hartman et al. 1984; Hartman and Scrivener 1990) and to earlier emigration and consequent reductions in ocean survival (Holtby 1988; Hartman and Scrivener 1990).

Summer water temperatures observed in many tributaries of the North Umpqua River downstream of Soda Springs Dam and unaffected by Project facilities and operations can approach or exceed the upper lethal temperature of 25°C (77°F) (Brett 1952) for juvenile coho salmon. Temperatures in the lower mainstems of Steamboat and Rock creeks exceed ODEQ water temperature criteria for spawning and rearing during some periods. High water temperatures that are below those considered to be lethal may also result in negative impacts to rearing coho. Growth rates in juvenile coho slow considerably at 18°C (64°F) (Stein et al. 1972) and cease at 20.3°C (68.5°F) (Bell 1973). Decreases in swimming speed may occur at temperatures over 20°C (68°F) (Griffiths and Alderdice 1972). These data suggest that juvenile coho in North Umpqua River basin tributaries suffer from reduced growth rates, which may decrease their likelihood of survival during overwintering and ocean residence periods, since survival increases with larger sizes (Hartman et al. 1987; Peterman 1982; Ward et al. 1989).

Whereas steelhead escape high water temperatures in tributaries by outmigrating as pre-smolts and rearing in the mainstem, this strategy is less likely to be a viable alternative for coho salmon, given their need for low water velocities and LWD cover, which are less available in mainstem areas, and their stronger fidelity to rearing territories.

Ocean conditions
Ocean conditions off the Oregon coast are highly variable and appear to be a critical factor in coho population fluctuations (Nickelson 1986). Adverse ocean conditions in the last two decades associated with reductions in upwelling along the Oregon coast (Bottom et al. 1986; Pearcy et al. 1992; Lawson 1993) are thought to have been a contributor to coho declines in Oregon (OCSRI Science Team 1996). In 1982 and 1983, North Umpqua River coho escapement declined to about 10 fish, which may have been due to El Niño conditions in those years.

From the 1950s to early 1980s, ocean fishery-related mortality of OC coho was likely 70% to 80%, a rate considered unsustainable (OCSRI Science Team 1996). These high harvest rates were likely an important factor in the depressed condition of coho in the North Umpqua River basin in the 1970s; the effects of past overfishing on the current status of coho populations are uncertain. Ocean harvest rates have declined since adoption of harvest limits in the early 1980s. In recent years, coho ocean harvest has been primarily restricted to incidental catches in chinook fisheries (Kostow 1995).

Predation
Striped bass predation on outmigrating smolts in the Umpqua River and estuary is likely a source of coho mortality, given the relatively small size of coho smolts (about 11 cm [4.3 in]; E. Waters, pers. comm., 1997). Although many members of the general public believe that predation by cormorants, seals, and sea lions is a major cause of coho salmon declines (public comments cited in OCSRI Team 1996), scientific studies indicate that predation by these native species is not a significant underlying cause of coho declines (Botkin et al. 1995).

Loss of access to historical spawning and rearing habitat
Coho salmon are reported to have historically migrated upstream in the North Umpqua River at least up to Fish Creek, upstream of the current Soda Springs Dam site (PacifiCorp 1995). Coho currently spawn and rear primarily in the lower portions of the watershed, preferring streams with gradients less than 3% (see “Abundance and Distribution in the Action Area” above). They generally do not prefer mainstem habitats for spawning and rearing, although mainstem spawning has been observed in the North Umpqua River (R. Grost, pers. comm., 2001). The construction of Soda Springs and Slide Creek dams blocked access to about 12.8 km (8 mi) of anadromous fish habitat in the mainstem North Umpqua River and Fish Creek (Synthesis Report, p. 7-69). The majority of this habitat is believed to be of relatively low quality for coho salmon spawning and rearing. Coho salmon have been found to prefer low-velocity alluvial habitats such as side channels, floodplains, and backwaters as rearing habitat (Everest et al. 1986; Glova 1986; Bugert and Bjornn 1991). Such habitat is largely lacking upstream of Soda Springs Dam, where reaches are typically confined (Synthesis Report, p. 7-67). LWD, which is an important feature of juvenile coho overwintering habitat, is limited in the mainstem North Umpqua River and lower Fish Creek because of the high capacity of these channels for transporting LWD.

Spawning gravel is also limited in these reaches due to their high transport capacity (Synthesis Report, p. 7-68 to 7-69). Within the Action Area, ODFW's Rock Creek Diversion Dam and fish ladder currently prevent upstream passage of about 30-50% of adult coho salmon to more than 44.5 km (27.5 mi) of low-gradient spawning and rearing habitat for coho salmon that exists upstream of this partial barrier (D. Loomis, pers. comm., 2001). The partial loss of access to this tributary habitat has likely had more effect on coho salmon in the basin than loss of access to mainstem habitats upstream of Soda Springs Dam.

Increased fine sediment inputs
Although data on the effect of fine sediments on coho eggs in the North Umpqua River basin are not available, increases in fine sediments in some basins used by coho for spawning may have reduced survival of coho eggs and alevins. Increased fine sediment input may be caused by logging, road construction and use, and occasional Project failures. An inverse relationship between the proportion of fines in spawning gravels and subsequent survival to emergence of coho salmon fry has been well-documented in other studies (Koski 1966; Hall and Lantz 1969; Cloern 1976; Tagart 1984). Survival to emergence of fry has been found to be high in laboratory and natural stream investigations where the percentage of fines is less than 5% and to drop sharply at over 15% fines (Koski 1966; Hall and Lantz 1969; Cloern 1976). Preliminary investigations using permeability measurements indicate that fine sediment does not appear to be impacting spawning areas in Rock Creek (Stillwater Sciences, unpublished data).

Hatchery influences
Hatchery stocking of coho in the North Umpqua River system began in the early 1980s, although stray hatchery fish from elsewhere in the Umpqua basin were counted at Winchester Dam in the 1970s (ODFW 1986). The ODFW management objective for hatchery coho is 3,500 adults (ODFW 1986), which slightly exceeds the average hatchery escapement of 3,400 between 1982 and 1995 (ODFW 1998). Survival of North Umpqua hatchery smolts appears to be above average compared to other Oregon stocks (PacifiCorp 1995). ODFW management goals also include returns of 1,300 wild coho, although management goals focus on hatchery fish (ODFW 1986). Between 1982 and 1995, hatchery escapement exceeded wild escapement in every year except one, and hatchery fish have composed as high as 90% of total escapement (ODFW 1998). Because many hatchery fish return to a trap at the Rock Creek Fish Hatchery, the ratio of hatchery to wild fish on spawning grounds further upstream is likely lower than the ratio at Winchester Dam (Kostow 1995).

Stocking of juvenile coho may reduce survival of native stocks through increased competition for limited space or food in rearing streams (Nickelson 1986). In streams, survival of juvenile hatchery coho can be lower than that of wild coho (Nickelson 1986). Competition for spawning sites can occur when the number of wild spawners are swamped by larger numbers of hatchery reared fish. The accelerated growth of fry in hatcheries may result in increased incidence of juvenile coho that return as jacks (Gross 1991). The interaction of hatchery and native stocks also increases disease potential, since native stocks may be exposed to disease organisms originating from hatcheries that they would not be exposed to under normal conditions

3.3 Watershed Conditions

3.3.1 Physical Setting

Throughout most of the Project area, the North Umpqua River flows through a narrow canyon with steep bedrock steps and benches. The area is characterized by a rich diversity of plants, wildlife, invertebrates and aquatic species in an area renowned for its natural beauty. About 90% of the study area is forested, with most Project facilities located in western hemlock and mixed conifer forests. The general characteristics of the watershed are described below.

Climate
The climate of the North Umpqua River watershed is similar to that of other large river basins in western Oregon and is typical of a moist maritime regime with wet, mild winters and dry summers. The mean annual temperature is 11.0°C (51.8°F) in Idleyld Park (located downstream of the Rock Creek confluence) and 8.1°C (40.1°F) in the area of Diamond Lake. Average annual precipitation in the study area ranges from 127 cm (50 in) in the lower elevations to 229 cm (90 in) at higher elevations; 80% of the annual precipitation typically falls between October 1 and March 31. During the winter, temperatures are generally below freezing at elevations above 915 m (3,000 ft). Above Toketee Falls, about 20% of the watershed lies above 1,524 m (5,000 ft); snowpack is, therefore, a major source of runoff in the upper portion of the watershed. As a result, streamflows originating within headwater streams are relatively stable throughout the year.

Topography and geology
The Oregon Cascades can be subdivided into two distinct geological provinces: the Western Cascades and the High Cascades provinces (Sherrod 1986). As in the rest of the Cascade Mountains, landforms in the North Umpqua basin reflect these two distinctive geologic provinces: (1) a predominantly moderately dissected topography defined by irregular ridges and forested straight, steep slopes (representative of the Western Cascade Range); and (2) a flat, relatively undissected high plateau (representative of the High Cascade Range). Most of the area from Idleyld Park upstream to the Lemolo No. 2 hydroelectric development occurs within the Western Cascade Range, while the Clearwater No. 1 and Lemolo No. 1 developments lie within the High Cascade Range. Elevations in the area range from 238 m (780 ft) near Idleyld Park to nearly 1,829 m (6,000 ft) at the headwaters of the North Umpqua River.

Vegetation
The Project vicinity includes four major vegetation zones: western hemlock forest, mixed conifer forest, subalpine forest, and interior valley (USFS 1990). A total of 569 vascular plant species were identified in or near the Project vicinity during relicensing surveys. Because of the area's biological diversity, the Oregon Natural Heritage Program has identified the entire North Umpqua River canyon from Glide to Lemolo Lake as a sensitive plant area.

Most of the area in the vicinity of the Project is forested; the remainder includes natural forest openings, meadows, rock outcrops, wetlands, and developed/disturbed land. The majority of the Project facilities are located within the western hemlock and mixed conifer forest zones, which are both common in the Project vicinity. The highest elevation Project facilities, such as Lemolo Lake, Clearwater No. 1 diversion (Stump Lake), and portions of Lemolo No. 1 and Clearwater No. 1 waterways, are located near the transition from the western hemlock and mixed conifer forest zones to the subalpine forest zone. Because of timber harvest and natural disturbances, over half of the forest stands in the upper watershed are in early and mid-seral successional stages, in which Douglas fir is usually the dominant species.

Downstream of the watershed analysis area, where the transmission line corridor extends to the west to Dixonville, the North Umpqua River basin consists of lower elevation foothills and wide rolling bottomlands that support vegetation typical of the interior valley vegetation zone. Less than half of this area is forested. Conifer forests, primarily composed of Douglas fir, occur on mesic sites on the top of the foothills, while oak savannahs occupy many of the hillslopes. The non-forested areas include grassland, pasture, cropland, shrubland, and rural development. Pastures and grasslands consist of a combination of native and non-native species. The conifer forest at these low elevations have been heavily logged and most of the non-forested areas and oak savannahs are used for cattle and sheep grazing. The relatively wide floodplain of the lower North Umpqua River basin supports a complex riparian zone with red alder, big-leaf maple, vine maple, and black cottonwood.

Riparian habitats

The steep topography of the North Umpqua River basin limits riparian forest to narrow bands; in some areas along the North Umpqua River, the canyon walls are too steep to support any riparian vegetation. The fractured surfaces of these basalt walls, however, are often densely covered with ferns, forbs, and sedges. Riparian areas are characterized by a number of plants that depend to varying degrees on channel morphology, hydrologic regimes, and other habitat conditions present along streams. Sedges and Indian rhubarb are found on bars and at the margins of streams, with horsetail present on more stable substrates. The woody vegetation immediately adjacent to stream channels typically consists of alder and willow; these species are seen on bars and frequently inundated floodplains throughout the watershed. Maples and Douglas fir occur on the upper stream banks, forming the transition zone between aquatic and terrestrial habitat, and together with alder, these trees make up the majority of the riparian overstory. At lower elevations in the watershed, cottonwoods can be found along the banks and floodplains of the larger alluvial streams.

Land ownership and management

The North Umpqua River basin is nearly completely located within Federally owned and managed lands from its headwaters downstream through the Project and farther downstream to the confluence of Copeland Creek (Land Ownership Map; Adjacent Land Ownership Map). With the exception of some transmission facilities, the Project is located entirely within the

Umpqua National Forest. Downstream of the Copeland Creek basin, public land managed by the USFS and BLM is interspersed with private land (Adjacent Land Ownership Map).

The Federal lands where the Project is located have been managed under the guidelines of the Northwest Forest Plan (NFP) since 1994 (USFS and BLM 1994). Most of the land surrounding Project features is allocated under the NFP as "Matrix," which is managed for both timber production and ecological function (Land Ownership Map). Downstream of Toketee Lake, much of the land is designated as "Late-Successional Reserve" (LSR). Land use and timber production is greatly curtailed in LSRs. According to the ROD (USFS and BLM 1994):

> *"Late-Successional Reserves are to be managed to protect and enhance conditions of late-successional and old-growth related species including the northern spotted owl. These reserves are designed to maintain a functional, interacting, late-successional and old-growth forest ecosystem. . . Late-Successional Reserves are also an important component of the Aquatic Conservation Strategy. . . Because these reserves possess late-successional characteristics, they offer core areas of high quality stream habitat that will act as refugia and centers from which degraded areas can be recolonized as they recover. Streams in these reserves may be particularly important for endemic or locally distributed fish species and stocks."*

Within Matrix lands and LSRs are riparian networks designated as Riparian Reserves. These reserves are lands along streams and unstable and potentially unstable areas where special protection standards and guidelines direct land use.

The Canton Creek basin, located within the Action Area downstream of the Project, has been designated a "Tier 1 Key Watershed" under the NFP. The Pass Creek subbasin within this basin is one focus for potential off-site habitat enhancement for anadromous fish, as described in the SA as mitigation for not providing fish passage at Slide Creek Dam. The watersheds provide a system of large refugia comprising watersheds that are crucial to at-risk fish species and stocks and provide high quality water. "Tier 1" (Aquatic Conservation Emphasis) contribute directly to conservation of at-risk anadromous salmonids, bull trout, and resident fish species. They also have a high potential of being restored as part of a watershed restoration program (USFS and BLM 1994).

Disturbance history

Hydroelectric power development

Winchester Dam was the first hydroelectric facility built on the North Umpqua River. The dam, which was constructed in 1890, was seven ft high (FCO and OSGC 1946). The dam was raised sometime between 1904 and 1922 (Bakken 1970; Boyle 1977) to its present height of 14 ft. It may have inhibited or blocked upstream movement of fish during low flow conditions (FCO and OSGC 1946) although a fish ladder was constructed in 1946 to facilitate upstream passage of adult salmonids. This dam is no longer used for hydroelectric power generation, but is retained for irrigation and to maintain the existing river scenery for local residents as well as for the fish counting station associated with the fish ladder.

Economic growth stimulated by World War II increased electricity demand in southern Oregon in the 1940s. In 1947, COPCO obtained licenses to construct the North Umpqua Hydroelectric Project, and by December 1949, the first of eight project facilities, the Toketee Unit, was operational. The hydroelectric project was completed in 1956. It involved constructing about 70 miles of road, 40 miles of canals and flumes, eight dams and powerhouses, and several smaller diversion dams. About 43 million board ft of timber were harvested during the construction, of which 21 million board ft were used in the construction of the Project itself (Boyle 1977). In 1961, COPCO merged with Pacific Power. The Project diverts water at dams or diversion structures from about 40 miles of stream channel on the North Umpqua River, Clearwater River, Fish Creek, Deer Creek, and a number of small tributaries. Flows are diverted into Project waterways, through powerhouses, and then returned to streams. Project reservoirs inundate portions of the North Umpqua and Clearwater rivers. A description of the hydroelectric project is provided above in Section 2.3.1.

Timber harvesting
Limited timber operations began in the North Umpqua watershed as early as 1876 and by 1904, larger-scale harvesting was underway locally in the Rock Creek basin (Bakken 1970). Stream channels sometimes served as skid roads for log transport (Clare and Marston 1968, as interpreted by Dambacher 1991). In the upper Steamboat Creek basin, virtually all of the streams adjacent to roads were cleared of large wood (USFS 1997b). The rugged terrain of the watershed limited access to much of the forest until the post-World War II era when road construction and timber extraction escalated through the 1970s. Throughout the 1970s, timber harvesting practices in the basin included removal of riparian trees, removal of logs and woody debris from stream channels, and construction of roads along valley bottoms.

Of the 1,029,449 acres in the Umpqua National Forest, 729,042 acres (71%) are considered suitable for timber production (USFS 1990). Many areas have been clear-cut and stands in various successional stages occur throughout the North Umpqua River watershed. Past timber harvesting activities have reduced mature and old-growth forest habitat in upland and riparian stands, and decreased coarse woody debris on the forest floor. Over half of the forest stands in the upper watershed are in early and mid-seral successional stages due to timber harvest and natural disturbances; Douglas fir is the dominant species in most of these stands.

Roads and road density
Based on data from the USFS and BLM, there are about 4,872 km (3,028 mi) of roads within the boundaries of the North Umpqua watershed. About 322 km (200 mi), or 6%, of these roads are associated with the Project. Of these 200 mi, about half are required exclusively for the Project; the other half are used jointly by the USFS and PacifiCorp (Schedule 15.2 to the Settlement Agreement, "Road Maintenance Responsibility," includes a list of roads maintained by

PacifiCorp). Based on traffic volume and width, State Route 138 probably represents the most significant road obstacle to wildlife movement in the watershed. Roads increase habitat fragmentation and reduce suitability of adjacent habitats. Most USFS roads and roads associated with the Project are fairly narrow and unpaved and probably reduce but do not completely prevent movement by most species.

Road densities in many subbasins of the North Umpqua River watershed (see Table 5) are greater than 2.5 km/km^2 (4 mi/mi^2); for example, road densities in the Rock Creek watershed are 3.1 km/km^2 (5 mi/mi^2) (BLM 1996). Valley-bottom roads are present along the mainstem North Umpqua River, larger tributary reaches such as Steamboat, Canton, Rock, and Copeland creeks, and along numerous smaller channels in these subbasins. Roads have modified channels in several areas of the Panther Creek subbasin, especially along the lower 2.4 km (1.5 mi) of Fairy Creek (Lightcap and La Marr 1993; Lightcap 1994). Although the density of streamside roads in the Action Area is not known, the average density of all roads is about 2.6 km/km^2 (4 mi/mi^2). There has likely been an increase in drainage network length and density in the North Umpqua River watershed due to the construction of roads in the basin.

Table 5. Road densities in selected areas of the North Umpqua River basin.

SUBBASIN	ROAD DENSITY		SOURCE
	km/km^2	mi/mi2	
Upper North Umpqua River (mainstem and tributaries from Toketee Dam upstream to Lemolo Dam)	2.1	3.4	USFS (1997a)
Upper Clearwater River (upstream of Clearwater No. 2 diversion dam)	2.0	3.2	USFS (1996a)
Upper Steamboat Creek (Little Rock, City, and Horse Heaven creeks, and headwaters of Steamboat Creek)	1.9	3.0	USFS (1997b)
Canton Creek	2.7	4.3	BLM (1995)
Rock Creek	3.1	5.0	BLM (1996)

Mining

In the North Umpqua River watershed analysis area, mining for gold has occurred in a few small areas, mostly in the upper Steamboat Creek basin where gold was discovered in 1863 (USFS 1997a). Limited coal mining occurred on the North Umpqua River and in the Little River area. Early mining used picks, shovels, and dynamite to find gold, but some placer mining may have also occurred (Walling 1884, Brauner and Honey 1977, both as cited in USFS 1993). Activities associated with mining included large amounts of local timber cutting for use in buildings, mine timbers, and for heat (USFS 1997a).

Commercial fisheries

Commercial fishing in the Umpqua River earlier this century likely contributed to population declines of anadromous fish. The Umpqua River basin once supported large commercial fisheries for coho, chinook, and steelhead. From 1892 to 1940, 30,000 to 250,000 coho were harvested annually in the Umpqua River. Only part of this harvest likely consisted of coho that spawned in the North Umpqua River, but these figures nonetheless suggest that escapements were previously much larger than they have been since Winchester Dam counts started (USFS et al. 1992). Coho abundance in Oregon coastal rivers, as inferred from commercial fisheries records, appears to have begun declining in the early 1900s, with the peak coastal cannery pack having occurred in 1899 (Cobb 1930, as cited in Gharrett and Hodges 1950). In the Umpqua River basin, sharp declines in coho abundance were evident beginning in about 1930 (Kostow 1995).

By the 1940s, spring chinook runs had declined to levels which were too small to support a commercial fishery in the Umpqua River (FCO and OSGC 1946). Spring chinook apparently had begun to decline in 1924 due to overfishing; an average of 4,500 spring chinook were harvested annually in the Umpqua River from 1923 to 1940 (some of which were South Umpqua River chinook) (FCO and OSGC 1946).

In 1933, population declines among Umpqua River summer steelhead prompted curtailment of the commercial steelhead fishery. In 1926, this fishery had harvested 18,000 pounds of summer steelhead in the Umpqua River (about 2,600 fish, assuming seven pound fish). Large harvests from 1926 to 1928 were followed by smaller harvests and a sharp decline in abundance until 1933 (FCO and OSGC 1946). Earlier this century, sea-run cutthroat occasionally supported intensive sport fisheries in the Umpqua River basin, although the species was never targeted by a commercial fishery (FCO and OSGC 1946; USFS et al. 1992).

Fish habitat modifications

In an effort to partially offset past LWD removal from stream channels, logs and boulder structures have been placed in some tributaries to the North Umpqua River; this continues to be an occasional activity of the USFS in the watershed analysis study area. During the 1980s, over 500 structures were placed in Steamboat Creek to improve fish rearing habitat (Dambacher 1991). In 1996, several hundred large logs were placed in Cedar Creek (a tributary to Steamboat Creek). A fish ladder was installed in 1959 at Steamboat Falls—a seasonal obstacle to upstream migration of fish—to facilitate fish passage during low flows (Dambacher 1991). In the North Umpqua River, log weirs and boulders were placed in the Soda Springs bypass reach (between the dam and the powerhouse) in 1992 to hold gravel. Gravel is periodically placed in this reach to create spawning habitat for spring chinook salmon.

3.3.2 Water Quality

NOAA Fisheries has identified water quality as an important component of the PFC pathway. Properly functioning indicators of water quality include temperature, sediment/turbidity, and chemical contaminants/nutrients. Suitable water quality and water temperatures are also essential elements of designated critical habitat (NMFS 2000).

Information on baseline water quality conditions and the effects of current Project operations on those conditions are summarized below. Information on stream reaches and reservoirs upstream of where listed anadromous fish would occur under the terms of the new FERC license is provided because water quality changes in these upstream reaches affect temperatures in the reaches downstream where listed anadromous fish would occur.

Temperature

High water temperatures can have both direct and indirect effects on juvenile and adult anadromous salmonids, including: (1) reduction of juvenile rearing area during summer, (2) increased susceptibility to disease, (3) increased vulnerability to predation, (4) reduced viability of eggs if adult females are exposed to high temperatures during upstream migration, (5) reduced ability to migrate long distances, (6) changes in macroinvertebrate communities and food availability, (7) reduced growth, (8) accelerated egg and alevin development and advanced emergence timing, which can increase susceptibility to displacement by high flows, and (9) formation of temporary barriers to upstream migration where high temperatures or low dissolved oxygen occur.

Impoundments and reduced instream flows related to Project facilities and operations, as well as timber harvesting and other anthropogenic disturbances, have the potential to increase water temperature. Increased water temperatures may affect fish migration and movements, and can result in direct and indirect effects on salmonids. Pacificorp (2002) includes tables showing the life history timing of anadromous salmonids in the North Umpqua River basin. Information on baseline conditions and effects of past Project operations on water temperature is summarized below.

ODEQ numeric water temperature criteria are measured as the 7-day moving average of daily maximum temperatures (7DMX) (PacifiCorp 2002a). ODEQ temperature criteria include the following:

- spawning (applies from spawning through fry emergence) = 12.8°C
- cold-water (applies remainder of the year) = 17.8°C

For coho salmon, the spawning criterion applies from mid-October through April; the cold-water criterion applies from May through mid-October (Table 4) (ODFW 2000). For steelhead, the spawning criterion applies from March through July; the cold-water criterion applies from September through February. For spring chinook salmon, the spawning criterion applies every month except August in the Action Area.

Continuous temperature monitoring occurred at 51 sites with sampling periods varying site to site from June 1992 to September 1999. For the range of sites monitored, the 7DMX ranged from 9.4° to 20.6°C (49.0° to 69.1°F) and occurred in the months of July and August. The highest 7DMX were recorded in Fish Creek.

In general, stream temperatures in the North Umpqua River increase in a downstream direction. Downstream warming through the Wild and Scenic River reach (extending from the Soda Springs powerhouse downstream to the confluence of the North Umpqua River and Rock Creek) occurs primarily as a result of solar warming and, to a lesser extent, as a result of warm water inflows from some tributaries. Water temperatures have increased at Winchester Dam on the lower mainstem North Umpqua River since the late 1940s (Johnson et al. 1994). The effects of the Project on water temperatures downstream of Soda Springs powerhouse are small (<1°C) (PacifiCorp 2002a).

Under the proposed action, providing fish passage at Soda Springs Dam would allow anadromous fish access to the Slide Creek full-flow and bypass reach, and to the lower portion of the Fish Creek bypass reach up to about RM 3.2, where a natural cascade impedes passage. Rainbow trout are the only native salmonid currently present in the Fish Creek bypass reach. Temperatures were monitored at two locations in the Fish Creek development. PacifiCorp monitored the upper and lower ends of the bypass reach (FISHT and FISHB), and the USFS also monitored temperatures at the lower end of the bypass reach (FSHBFS). PacifiCorp monitored the lower end of the bypass reach from 1992 to 1998, although not all months were monitored every year. The USFS monitored this location from June through October in 1998 and 1999.

Temperatures in the upper end of the Fish Creek bypass reach exceeded the cold-water criterion in July and August. July 7DMXs peaked at 18.8°C (65.8°F) in 1992. August 7DMXs were only greater than the cold-water criterion of 17.8°C (64.0°F) during one of the seven years monitored. The maximum 7DMX (19.3°C [66.7°F]) was recorded during drought conditions. With the exception of 1992, the peak August 7DMX was 17.5°C (63.5°F).

Under current conditions, flow diversions by the Project increase summer water temperatures in lower Fish Creek (PacifiCorp 1995). Past logging and grazing in the Fish Creek basin may also have increased stream temperatures. During the relicensing studies, maximum water temperatures recorded in Fish Creek were 22°C (72°F) (PacifiCorp 1995); these temperatures are higher than those preferred by juvenile anadromous salmonids, but lower than the maximum temperatures observed in many tributary basins currently used by anadromous salmonids in areas downstream of the project-affected reaches. Other water quality indicators in Fish Creek, including dissolved oxygen, pH, and macroinvertebrate communities (PacifiCorp 1995, Vol. 21), are within the range suitable for anadromous salmonids.

PacifiCorp monitored the North Umpqua River at three locations in the Slide Creek development. The locations were the upper and lower ends of the Slide Creek bypass reach (SLIDT and SLIDB) and the full-flow reach about 0.32 km (0.2 mi) downstream of the Slide Creek powerhouse (SODARI). The 7DMXs for the upper end of the bypass and the full-flow reach were similar. During 1994, both of these sites had 7DMXs of about 13.5°C (56.3°F) during June and 14.5°C (58.1°F) during July. Modeling conducted in the Slide Creek bypass reach (bottom) indicates that the cold water criterion of 17.8°C during the period of May through mid-October is not exceeded under proposed instream flows (PacifiCorp 2002a).

PacifiCorp monitored temperatures at the lower end of the Soda Springs bypass reach (SODAB). June 7DMXs reached 14.7°C (58.5°F) during 1992, but did not exceed 12.8°C (55.0°F) during any of the other three years monitored. In contrast, 7DMXs for July were greater than 12.8°C during each of the five years monitored, but did not exceed 17.8°C. Soda Springs bypass reach temperatures remained below the applicable temperature criterion during the remainder of the monitoring period.

Water temperature was monitored at two sites in the North Umpqua River downstream of the Soda Springs powerhouse, the Soda Springs Gage (SODAG) and the Copeland Gage (COPEG), which are 0.5 and 3.4 km (0.3 and 2.1 mi), respectively, downstream of the powerhouse. Note that Boulder Creek enters the river between these two sites. During June of 1996, the 7DMX reached 13.3°C (55.9°F). However, the cold water criterion of 17.8°C during the period of May through mid-October is not exceeded under current or proposed instream flows (PacifiCorp 2002a).

In addition to temperature monitoring, PacifiCorp used two water temperature models to predict conditions that would occur under varied Project operations (PacifiCorp 2001). These models were the U.S. Fish and Wildlife Service's SNTEMP and SSTEMP models. During the FERC relicensing process, PacifiCorp consulted extensively with ODEQ and other agencies on the appropriateness of these models and their use. The models' prediction of 7DMXs were used to determine the temperature changes that would be expected by increasing minumum bypass reach flows.

The SNTEMP model provides a basis for describing the effects of flow regulation on water temperatures. The description that follows is based on modeling results reported in PacifiCorp (1995) for mean daily maximum water temperatures during the week of 15–21 July 1992. This week was chosen to represent a period when water temperatures would be expected to be high.

During mid-July, water temperatures in the mainstem North Umpqua River are relatively cold in the upper reaches of the Project area. The modeled downstream warming rate below Lemolo Lake is about 0.22°C/km in late July.

As water moves downstream through the North Umpqua River bypass reaches, full-flow reaches, and reservoirs, mid-July 7DMXs increase from about 10°C (50°F) at Lemolo Lake to about 14° to 15°C (57° to 59°F) in the vicinity of Soda Springs powerhouse. Without any diversion of flow, this increase would occur gradually, with slight local increases or decreases attributable to tributary inflows. Flow diversions generally cause temperatures to warm more rapidly within the bypass reaches, but the diversions may in some cases produce cooler temperatures where the remaining flow is dominated by relatively cold tributaries or springs.

The first bypass reach below Lemolo Lake is the Lemolo No. 1 bypass reach. The highest 7DMX measured in July at the bottom of the reach (LEM1B) was 14.5ºC (56.3°F). Within the Lemolo No. 2 bypass reach, the current minimum flow causes the river to warm in the upper portions of the reach, but it allows cold water from tributaries and springs to dominate warmer river water in the lower portion of the reach. Thus, the highest 7DMX measured in July at the bottom of the reach (LEM2B) was only 14.4ºC (57.9°F), which is slightly cooler than the highest July 7DMX measured upstream at the bottom of the Lemolo No. 1 bypass reach.

Poor mixing of water within Toketee Lake affects water temperature conditions downstream within the Toketee bypass reach. Warm water from the North Umpqua River flows along the north side of the reservoir and is diverted into the tunnel leading to the Toketee powerhouse. Cold water from the Clearwater No. 2 bypass reach enters Toketee Lake, mixes little with the warmer North Umpqua River water, and flows into the Toketee bypass reach. As a result, most of the water in the Toketee bypass reach is cold water from the Clearwater River. The highest 7DMX measured in July in the Toketee bypass reach was 13.0°C (55.4°F).

Immediately below the Toketee bypass reach, relatively warm water from the North Umpqua River and Fish Creek are discharged into the river through the Toketee and Fish Creek powerhouses, respectively. This causes the river to warm significantly within a short distance. Whereas the maximum July 7DMX measured at the bottom of the Toketee bypass reach was 13.0°C (55.4°F), the maximum July 7DMX measured at the top of the Slide Creek bypass reach, less than half a mi downstream, was 14.4°C (57.9°F). In addition, Fish Creek enters the North Umpqua River at about the middle of the Slide Creek bypass reach. The warm water of Fish

Creek causes warming of the lower portion of the Slide Creek bypass reach. The highest July 7DMX measured at the bottom of the bypass reach was 18.6°C (65.5°F), more than 4°C than the highest July 7DMX measured at the top of the bypass reach. Just downstream of the mouth of Fish Creek, the Slide Creek powerhouse discharges cooler water into the North Umpqua River, cooling it to temperatures similar to those that would occur under undiverted conditions.

Soda Springs Reservoir, immediately downstream of the Slide Creek powerhouse, reduces daily water temperature fluctuations downstream. Downstream of Soda Springs Reservoir, the water is warmer at night and cooler during the day than it would be without the reservoir because the discharge is about the same temperature day and night. Within the short Soda Springs bypass reach, the diversion of river flow allows water from cold-water springs to dominate, resulting in somewhat cooler temperatures than would occur without the diversion.

Although the Project has important local temperature effects, the cumulative effect below Soda Springs powerhouse is small. Summer water temperatures in the lower mainstem North Umpqua River near Winchester Dam are often warmer than is optimal for salmonids, not as a result of the Project, but as a result primarily of natural warming of the river and secondarily of tributary inflow of warm water. Stream temperatures in the lower mainstem of tributaries such as Steamboat and Rock creeks exceed ODEQ water temperature criteria for spawning and rearing during some periods. Assessment of the potential effects of project facilities and operations on listed anadromous salmonids is discussed in Section 4.

Effects of forest management and other land-use disturbances on stream temperatures

Although data on water temperatures that existed prior to timber harvesting in the basin are limited, logging of riparian areas appears to have raised water temperatures in some areas of the North Umpqua River basin since the 1960s. Brown et al. (1971, as cited in Johnson et al. 1994) identified logging-induced temperature increases of over 8°C (14°F) in a 1,280 m (0.8 mi) reach of Cedar Creek (a tributary of Steamboat Creek) by comparing temperatures in reaches upstream and downstream of clear-cuts. The removal of streamside vegetation results in increases to summer water temperatures; smaller streams generally exhibit relatively larger temperature increases because a greater proportion of their surface area will be newly exposed to the sun (Chamberlin et al. 1991). Heat added to a stream is not readily dissipated and so water temperature increases in headwater streams result in cumulative increases to water temperatures in downstream reaches (Beschta et al. 1987). Increased water temperatures that are a result of clear-cutting in riparian areas or natural disturbances such as debris torrents will subsequently decline as riparian vegetation regrows.

Evidence suggests that areas of the North Umpqua River basin that previously experienced water temperature increases related to timber harvesting may now be recovering, but some reaches (especially in Steamboat Creek upstream from the mouth of Canton Creek) are still characterized by water temperatures close to the upper lethal limit of juvenile anadromous salmonids

(24°–26°C [75°–79°F]). Current restrictions on harvesting in streamside areas resulting from the implementation of the NFP (USFS and BLM 1994) should continue to reduce water temperature impacts resulting from past timber harvesting in riparian areas on Federally-owned forestlands. However, management restrictions on headwater streams and state and private forestlands are less stringent than on Federal lands and may be failing to prevent increases to stream temperatures.

Climatic changes have possibly contributed to the warming trend observed in the North Umpqua River (Redmond 1993); however, effects of land-use and/or natural disturbances to riparian habitats and stream channel morphology may also be contributing to cumulative effects on mainstem water temperatures. Water temperature increased significantly in the late 1950s through the 1960s, coinciding with the beginning of intense logging activity in some subbasins (for example, Steamboat Creek, Rock Creek, Little River). While temperatures in some tributaries appear to have decreased since then, apparently as a result of the regrowth of riparian vegetation, similar downward trends have not been observed in the mainstem North Umpqua River. High summer water temperatures above 20°C (68°F) regularly occur in the lower mainstem North Umpqua River and in many tributaries.

Holaday (1992) found that from 1969 to 1990, significant decreases in maximum daily summer stream temperatures occurred in Steamboat Creek and its tributaries above Canton Creek, with the smallest decreases occurring on streams with little or no history of timber harvesting along the stream's length and on streams with summer base flows greater than 0.42 cms (15 cfs). Regrowth of riparian vegetation that had been removed by flooding (especially in the 1964 flood), debris torrents, or streamside harvesting (riparian buffer strips began to be used in the mid-1970s) appeared to be the major cause of observed decreases in temperatures. Boulder Creek (a control stream where very little timber harvesting occurred) water temperatures did not significantly decrease during the same period, supporting the hypothesis that stream temperatures were decreasing with regrowth of riparian vegetation. Holaday (1992) found that maximum daily stream temperatures in lower Steamboat Creek did not change significantly from 1969 to 1990 and suggested that lower Steamboat Creek may have historically been characterized by high stream temperatures.

In Cedar Creek, where temperatures have been observed to increase following logging, a 7°C (13°F) drop in stream temperatures was recorded from 1973 to 1989, following cessation of riparian logging and regrowth of riparian vegetation (Dambacher 1991). Although Dambacher (1991) observed a decreasing trend in Steamboat Creek temperatures from 1969 to 1989, high summer water temperatures continued to occur.

Other anthropogenic disturbances that may contribute to cumulative effects on stream temperature increases include road construction in valley bottom areas and road/stream crossings, development of riparian areas for recreation, and grazing of livestock in riparian areas.

Turbidity and suspended sediment

Turbid water conditions may interfere with the vision of some aquatic organisms, including salmonids, and may therefore reduce feeding efficiency (Berg and Northcote 1985), growth (Sigler et al. 1984), or the ability to negotiate obstacles. Sublethal effects of increased turbidity may also include temporary displacement, damage to gill tissues, temporary reduction in growth rate, and temporary delays in adult upstream migration (Cordone and Kelly 1961, as cited in Bjornn and Reiser 1991). However, short-duration events of elevated turbidity and suspended solids are unlikely to produce significant lasting effects unless the levels are extremely high as fish are often exposed to short-term natural increases in turbidity and are thus well adapted for these events (Sorenson et al. 1977, as cited in Bruton 1985). Some studies have shown that low to moderate turbidity levels (those less than about 20 to 30 nephelometric turbidity units [NTU]) have no effect upon salmonid feeding activity or may actually benefit certain fish species by providing them with cover from predation, thus allowing greater feeding and activity levels (Noggle 1978; Bisson and Bilby 1982; Gradall and Swenson 1982; Gregory and Northcote 1993). Short-term turbidity increases of 25 to 30 NTUs and above tend to alter salmonid behavior due to the loss of visual reference, resulting in reduced activity, reduced feeding, and reduced intra- and inter-specific aggression and territoriality (Berg 1982).

Canal breaks and associated landslides can cause marked increases in turbidity; 20 canal and flume failures have been documented at the Project since 1957 (USFS 1997a). Spills of water from canals onto unvegetated hillslopes may cause turbidity increases (Mills 1994). The maximum turbidity measured during relicensing studies was 47 NTUs at the mouth of Potter Creek. The overtopping of the Lemolo No. 2 canal and undercutting of a road bench caused a landslide in the Potter Creek drainage during a March 1993 rain-on-snow event, which led to the increased turbidity. The effects of a waterway failure on turbidity were evaluated in February of 1996 when a mudslide buried part of the Clearwater No. 2 canal, causing the canal flow to spill over the road, washing out several ephemeral channels and gravel roads. The resulting plume of turbidity was measured at 70 NTU in the North Umpqua River downstream of Toketee Dam. Within 12 hours of the canal failure, turbidity in the Clearwater River had dropped to about 17 NTUs. For comparison, during a flood several days later, turbidity in the North Umpqua River was measured at from 20 to 30 NTUs in the same reach. Canal failures usually occur during the winter and during high flows when peaks of turbidity would occur under natural conditions. These events are similar to turbidity peaks expected to occur under natural conditions when mass wasting events occurred, and are therefore not likely to cause harm to the riverine ecosystem or anadromous salmonids.

Turbidity increases associated with the Project may also occur during upramping events related to facilities maintenance operations or unplanned shutdowns. Ramping rates during facilities maintenance releases in 1994 and 1995 were limited to about 15 cm/hr (6 in/hr), offering an opportunity to compare effects of restricted versus unrestricted ramping rates on turbidity. In 1993, when upramping rates were unrestricted, the highest turbidity occurred at the downstream end of the Clearwater No. 1 bypass reach (9.5 NTUs)—no other areas exceeded 4 NTUs in 1993.

In general, turbidity levels were lower in 1994 than in 1993, although limiting upramping rates did not significantly reduce turbidity in the Soda Springs, Fish Creek, and Lemolo No. 1 bypass reaches. The largest turbidity increases in 1995 occurred in the Soda Springs bypass reach, where turbidity rose from 1.5 to 9 NTUs despite use of the slowest upramping rate (2.3 in/hr [5.8 cm/hr]) of all reaches. In the Clearwater No. 1 bypass reach, reduced ramping rates corresponded with reduced turbidity increases, although turbidities in this reach remained high compared to other reaches in 1994 and 1995, suggesting that the Clearwater No. 1 bypass reach may be particularly susceptible to turbidity increases.

Unplanned shutdowns (or outages) lasting over three hours usually require some amount of flow to be diverted into bypass reaches until the outage is corrected. Depending on the conditions existing at the time of the outage, upramping in these bypass reaches may need to occur more rapidly than during planned shutdowns and increased turbidity may result. On average, unplanned shutdowns occur less than twice a year and the duration of the event usually is less than 24 hours.

Turbidity measured during June 1992 through September 1994 ranged between 0.1 NTU and 46.5 NTU (PacifiCorp 1995a, Vol. 21, Sec. 2.2.1.3). Turbidity measurements were typically 1 NTU or less, and most measurements greater than 2 NTU occurred during January and March 1993 rain-on-snow runoff events. With the exception of the rain-on-snow events, PacifiCorp's periodic measurements of turbidity during the high runoff period in the spring of 1993 exhibited low turbidity levels throughout the Project area.

Turbidities were also low during the low-flow periods of June through October 1992 and July through October 1993. Average turbidity was about 1 NTU among all sites from June through December of 1992 and from February through November 1993 (excluding the rain-on-snow event measurements). Increases in turbidity in the lower North Umpqua River and Fish Creek basins that occurred between October and December 1992 probably represented a first-flush effect of increased flows following a prolonged dry period.

The highest turbidity was measured at the mouth of Potter Creek during March 1993, after a landslide occurred along Potter Creek. The landslide was caused by over-topping of the Lemolo No. 2 canal, which resulted in the saturation and failure of side-cast fill along the Lemolo No. 2 canal road. Turbidity measurements in Slide Creek at the mouth (SLIDM) also exhibited relatively high values compared to other sites throughout the monitoring period. This turbidity was attributed to timber harvest and road-building activities in this small (5.5 square mi) watershed, which is not affected by the Project.

Project operations, such as maintenance, can also cause turbidity increases of limited duration. Turbidity increases occur during upramping events related to facilities maintenance or unplanned shutdowns. Turbidity increases related to increased flows caused by annual maintenance of PacifiCorp's developments exceeded 10% at six of the seven sites where data were collected in 1993 and at all sites in 1994 and 1995. This was largely because the ambient turbidity was so low that any high-flow event, natural or otherwise, would result in more than a 10% increase. During these events, turbidity levels typically increase up to 4 NTUs and sometimes may increase up to 9 NTUs, but the events are often not visible. The elevated levels of turbidity may persist for up to 24 hours before returning to background levels. These increases in turbidity are not likely to have adverse effects on aquatic resources because of their short duration and low levels.

In general, pulses of turbidity associated with Project operations are generally of lesser magnitude and shorter in duration than those turbidities that have been reported to cause reduced feeding or growth (Berg 1982; Sigler et al. 1984; Berg and Northcote 1985) or avoidance behavior (Bisson and Bilby 1982; Sigler et al. 1984) in juvenile salmonids. Short-term increases in turbidity associated with facilities maintenance or other project operations do not appear to be outside the range that would be expected under natural conditions.

Nutrients

Because the soils of the Cascades Range are relatively rich in phosphorus, the primary productivity (algae growth rate) of waters in the basin is generally limited by nitrogen. In fact, much of the time the concentrations of both organic and inorganic nitrogen are so low as to present a challenge to analytical methods. PacifiCorp sampled nutrients in the Project vicinity from May 2000 to April 2001 to document nutrient concentrations entering and traveling through the Project (Eilers and Raymond 2001). Results indicate that the nutrients in the North Umpqua River do not decrease or increase monotonically proceeding downstream within the Project. All forms of nitrogen in Lake Creek (inlet to Lemolo Lake) were higher compared to the North Umpqua River entering Lemolo Lake. Total inorganic nitrogen concentrations below Soda Springs powerhouse are nearly identical to those above the Project in the North Umpqua River and lower than those in Lake Creek. There is no evidence that the Project is increasing nutrient concentrations below Soda Springs powerhouse.

The only Project reservoir that experiences algal blooms is Lemolo Lake. An algal bloom typically lasting for one week or less occasionally occurs in Lemolo Lake in July or August. Turbidity levels in the Lemolo No. 1 bypass reach below the reservoir are very low. There is no evidence of an associated increase in turbidity in this reach during algal blooms, nor would any significant increase in river turbidity be expected from such an event. The algal blooms in Lemolo Lake are typically confined to the upper 6 m (20 ft) of the reservoir, while the outlets for both the bypass reach and canal flows are about 20 m (66 ft) or more deep. Therefore, it is unlikely that the algae are transported downstream.

Increases in nutrients may result in objectionable or deleterious growths such as fungi, bacterial slime, sulfur bacteria, stalked diatoms, or nuisance levels of algae. These conditions, in turn, may result in increases in hydrogen ion concentration (pH), increased levels of organic materials in sediments, as well as large diel fluctuations in pH, reduced intergravel dissolved oxygen (IGDO), high total organic carbon concentrations in sediments, and relatively high Hilsenhoff Biotic Index (HBI). The HBI describes the relative tolerance of benthic taxa to organic enrichment. The scale ranges from 0 to 10 with low scores from 0 to 5 indicating intolerance of polluted conditions.

During the relicensing studies, periphyton was documented in Project powerhouse tailraces and below Project dams but not at concentrations that appear to have significant adverse effects on water quality or beneficial uses. Measurements of IGDO were high throughout the Project, indicating that organic debris or sediment is not filling interstitial spaces in the stream gravels (PacifiCorp 1995). In addition, all HBI values were below 5, except for one reading of 5.3 at the top of the Lemolo No. 1 bypass reach. These values also indicate an absence of polluted conditions.

The Lemolo No. 2 full-flow reach is the only stream reach in which pH values outside ODEQ criteria range have regularly been found. These criteria exceedances, however, are relatively small (no more than 0.4 outside the criteria range) and occur for only 2 to 3 hours on some late summer afternoons. It is not known if these afternoon high pHs occur for one or several weeks or if they occur every year. The elevated pH levels are the result of water with elevated pH in the Lemolo No. 2 forebay (Harza and RTG Fishery Research 2000). This water is carried through the Lemolo No. 2 powerhouse and discharged into the Lemolo No. 2 full-flow reach. Habitat mapping of the Lemolo No. 2 forebay indicates that aquatic macrophytes cover over 90% of the bottom area. Primary production in the forebay appears to be the cause of the elevated pH levels.

The Lemolo No. 2 forebay supports a productive fishery, and the full-flow reach seeds the popular Toketee Lake fishery. There is no indication that beneficial uses are adversely affected by the late summer, late afternoon increases in pH. The highest growth rates for trout were found in the Lemolo No. 2 forebay, and healthy populations of spawning and rearing trout have been well-documented in the Lemolo No. 2 full-flow reach.

Effects of forest management and other land-use disturbances on nutrients

Timber harvest (especially clear-cutting) accelerates the decomposition of organic matter on the forest floor, and thus accelerates the leaching of nitrogen to streams. It also temporarily interrupts the uptake of nutrients by vegetation (Fredricksen 1971). Nitrification - the conversion of relatively immobile ammonium to mobile nitrate - is not a dominant process in western coniferous soils, but it can occur in patches in the forest landscape, especially beneath stands of alder. Disturbing such patches (through timber harvest, for example) can stimulate nitrification by accelerating the decomposition of organic matter and reducing the carbon to nitrogen ratio (Coats et al. 1976). A recent study in the South Umpqua basin found that nitrate plus nitrite concentrations in streams draining clear-cut catchments were three times higher than in streams draining patch clear-cut or shelterwood thinned areas (Greene et al. 1996). Studies in the H. J. Andrews Experimental Forest (Vanderbilt et al. 1996) found nitrate export (kg/ha) to be elevated for up to six years following logging. Part of the increased export was due to the increased streamflow that accompanied the timber harvest. The effects of timber harvest tend to diminish as a new stand develops, but in actively managed forests there will always be some areas where nutrient loss is accelerated.

Until 1994, Umpqua National Forest lands were heavily fertilized with nitrogen. In 1993, about 232 tons of nitrogen were spread by helicopter in the North Umpqua Ranger District (Jones 1995, as cited by Anderson and Carpenter 1996). More detailed data on rates of use are not readily available and have not been reviewed. The practice was ended after 1993 because of concerns about potential water quality effects, but it seems likely that forest fertilization has contributed to the nitrogen loading of basin streams. Studies on the water quality impacts of forest fertilization have shown that impacts may be significant but are most likely temporary (Moore 1975). Forest soils in the Pacific Northwest are generally deficient in nitrogen. Once the applied nitrogen is incorporated into the terrestrial nutrient cycle, it is probably recycled efficiently and is not subject to significant leaching loss. Fertilizer applied to exposed or barren soils, however, especially highly porous pumice soils (which are characteristic of some portions of the basin), would be vulnerable to leaching.

Chemical contamination

Sediment samples collected from the North Umpqua River below Steamboat Creek and above Rock Creek in September 1993 (a low flow period) were tested for trace elements and organochlorine compounds. None of 87 pesticides analyzed were present. Tests were conducted for 13 metals, hardness, and total dissolved solids. Copper was detected at Soda Springs bypass reach and lead was detected in Fish Creek. All tests for metals in the Lemolo No. 1, Lemolo No. 2, and Clearwater No. 2 bypass reaches were below detection limits. There is no reason to believe that any of the detected metals were associated with the Project or that metal concentrations in North Umpqua River basin waters pose any threat to aquatic life.

Dissolved oxygen

Optimum dissolved oxygen (DO) concentrations for salmonids are considered to be those at or near air-saturation, although growth and performance do not appear to be impaired at concentrations near 8 mg/l (8 ppm) (76% to 93% saturation) (Davis 1975). Initial effects of DO deprivation occur near 6 mg/l (57% to 72% saturation) (Davis 1975). High levels of DO (9 mg/l [9 ppm]) are critical for incubating salmonid eggs. Salmonids typically construct redds in pool tailouts or heads of riffles where high levels of IGDO are available.

The ODEQ criterion for dissolved oxygen in areas used by salmonids for spawning and rearing is >6 mg/l, or no change from background concentrations.

PacifiCorp collected IGDO data from known anadromous fish spawning areas and potential native trout spawning areas in stream reaches affected by the Project. The data were collected during the spring and fall of 1994 and in the late summer of 2000. A standpipe was driven into the gravel and then a peristaltic pump was used to collect a water sample from within the gravels (Grost and Bonoff 1997). In addition to the intergravel samples, surface samples were collected for dissolved oxygen analysis to enable computation of oxygen deficits in the gravels.

The spatial medians of IGDO measurements ranged from 8.2 mg/l to 11.4 mg/l. The lowest value was measured in the Soda Springs Bypass Reach during May 1994 within a spring chinook redd after fry emergence. All the other spatial median IGDO values were 9.0 mg/l or higher. Oxygen deficits computed by subtracting the spatial median IGDO from the mean surface dissolved oxygen ranged from 0.2 mg/l to 1.2 mg/l.

Dissolved oxygen was measured in streams and powerhouse tailraces in the vicinity of the Project on a periodic basis from June 1992 to October 1994 and during diel studies conducted between May 1993 and September 1999. During existing salmonid spawning to emergence periods, periodic and supplemental measurements of dissolved oxygen concentrations in streams ranged from 7.0 to 14.7 mg/l. Dissolved oxygen ranged from 7.0 to 14.5 mg/l in bypass reaches (1 out of 189 measurements was less than 8.0 mg/l), from 8.2 to 14.7 mg/l in full-flow reaches, and from 7.9 to 12.7 mg/l in tributaries (1 out of 31 measurements was less than 8.0 mg/l). Of the 4,966 diel measurements made in Project-affected reaches, only 200 (4%) had dissolved oxygen concentrations of less than 9.0 mg/l. By contrast, 60% (309 measurements out of 507) of the diel measurements at sites not affected by the Project had dissolved oxygen concentrations of less than 9.0 mg/l.

During rearing periods, 3 of the 216 periodic and supplemental dissolved oxygen measurements at stream, spring, powerhouse, and canal sites had dissolved oxygen concetrations less than 8.0 mg/l. Dissolved oxygen measurements ranged from 7.3 to 13.0 mg/l in bypass reaches, 9.6 to 11.5 mg/l in full-flow reaches, 10.2 to 11.1 mg/l in Project canals, and 6.1 to 14.7 mg/l in powerhouse tailraces. In comparison, measurements at sites not affected by the Project ranged from 6.9 to 11.4 mg/l in tributaries and 10.7 to 12.2 mg/l in springs.

In addition to the periodic water quality sampling, PacifiCorp conducted extensive sampling of dissolved oxygen at some sites during high and low flows and during facility maintenance events. Dissolved oxygen concentrations of less than the 6 mg/l criterion were recorded during some of the events sampled, but no one site stood out for its failure to meet applicable water quality criteria. Low dissolved oxygen concentrations were measured during high flows at the upstream end of the Lemolo No. 1 bypass reach, during canal maintenance events at the downstream end of the Slide Creek bypass reach, and during low flow at the upstream end of the Fish Creek bypass reach. During diurnal sampling conducted in late July and August, low dissolved oxygen concentrations were measured in Lake Creek upstream of Lemolo Lake, in the Lemolo No. 2 full flow reach, in the North Umpqua River at USGS Gage 14316500, and in Steamboat Creek near its mouth.

In Project impoundments and forebays, dissolved oxygen was studied in vertical profiles. All measured dissolved oxygen concentrations in Project impoundments and forebays exceeded the applicable water quality criteria.

Gas supersaturation

Supersaturation of dissolved gases can cause “gas bubble disease” in fish, which may result in both direct and indirect mortality. Direct mortality results from air emboli in heart and gill filaments, damage to vital organs, or red blood cell hemolysis (dissolution or destruction of red blood cells) (Marsh and Gorham 1905; Pauley and Nakatani 1967, all as cited in Dawley and Ebel 1975). Indirect mortality may occur as a consequence of increased vulnerability to disease (Coutant and Genoway 1968, as cited in Dawley and Ebel 1975), or increased vulnerability to predation due to reduced swimming performance resulting from exposure to sub-lethal levels of supersaturation (Dawley and Ebel 1975). Gas bubble disease may adversely affect both upstream and downstream migrating salmonids (Ebel 1970; Ebel and Raymond 1976, as cited in Bjornn and Reiser 1991).

Air is entrapped in water when water is spilled over heights, such as waterfalls and dams. When the Project turbines are operated at minimum flows, air is admitted through a valve to prevent cavitation, which damages the blades. Air then becomes entrapped and the water becomes supersaturated with gas. The dissolved gas can enter the bloodstream of aquatic organisms, where it comes out of solution to form bubbles.

The ODEQ criterion for total dissolved gases (TDG) is that TDGs shall not exceed 105% in waters less than 2 ft deep, or 110% in waters more than 2 ft.

Total dissolved gases were measured during periodic water quality surveys in the Project area from June 1992 to September 1994. Measurements of TDGs yielded a range of values from 94% to 121% saturation (values were most often between 100% and 105%). High TDG measurements were associated with the Lemolo Nos. 1 and 2 and Clearwater No. 2 facilities. In September 2001, PacifiCorp studied the relationship between TDG saturation levels and the power generation levels and the use of the air admission system at these powerhouses (Columbia Basin Environmental 2001). In general, TDG levels were negatively correlated with power generation levels and were higher with the air admission system open than with it closed. High TDG levels at these facilities did not typically persist more than a quarter-mile downstream.

The potential for high TDG saturation levels to harm aquatic organisms is related to the compensation depth, i.e., the depth at which hydrostatic pressure equals TDG pressure (Bouck 1980; USACE 1992). Below this depth, gases remain dissolved and gas bubbles do not form. By detecting harmful concentrations and remaining in deeper water than the compensation depth, fish can escape the potentially deleterious conditions associated with high TDG saturation levels. A study of chinook salmon and steelhead showed that they were capable of detecting super-saturated conditions and avoiding their effects by moving vertically (Dawley et. al. 1976). During the diurnal TDG study, tailrace depth was always 2 to 4 m (7 to 13 ft) deeper than the maximum compensation depth. Thus, fish could reside free of super-saturated conditions at all three powerhouse tailraces. Fish may also avoid super-saturated conditions in the powerhouse tailraces by moving laterally into the associated bypass reaches or into Toketee Lake in the case of the Clearwater No. 2 Powerhouse. The ability to detect super-saturated conditions and move laterally to avoid them was reported for juvenile rainbow trout and for coho, sockeye, and chinook salmon (Stevens et al. 1980).

Measurement of TDG saturation levels during annual facilities maintenance flow releases at Project facilities indicated that upramping rates did not appear to influence TDG levels.

PacifiCorp (1995) examined trout in 1993 during powerhouse TDG studies and found no external signs of gas bubble disease. Fish were sampled at and downstream of the Lemolo No. 1 and No. 2 and Clearwater No. 1 powerhouses, but most of the fish caught were from the Lemolo No. 1 powerhouse tailrace. Fish were not examined below Soda Springs Dam, since measured TDG concentrations there were always within applicable water quality criteria. Only one fish was sampled below Lemolo No. 2 powerhouse, where relatively high TDG levels have been recorded.

3.3.3 Habitat Access and Physical Barriers

NOAA Fisheries has identified habitat access as an important component of the PFC pathway. Properly functioning indicators for this pathway are physical barriers. Migration corridors are also identified as a critical habitat essential habitat type, and safe passage conditions are identified as an essential feature of critical habitat (NMFS 2000). In addition, terrestrial and riparian habitat connectivity are important for listed wildlife species, and may also be affected by the Project. Information on baseline habitat access conditions and the effects of existing Project operations on habitat access is summarized below.

Upstream passage for adult salmonids

Dams and other hydroelectric facilities can create obstacles or barriers to upstream movement. Winchester Dam is the most downstream dam on the North Umpqua River, located 11 km (7 mi) upstream from the river's confluence with the South Umpqua River. A fish ladder allowing passage and the counting of upstream migrating fish has been in operation since 1946 at the dam.

Soda Springs and Slide Creek dams are downstream of Toketee Falls, which was the most upstream natural barrier to anadromous fish on the North Umpqua River under pre-Project conditions. Neither of these dams has a fish ladder and therefore both block upstream migration of anadromous fish to historically accessible habitat. Soda Springs Dam blocks access to about 10.6 km (6.6 mi) of habitat for anadromous fish, including 5.5 km (3.4 mi) in the North Umpqua River and 5.2 km (3.2 mi) in Fish Creek. Confined channels and coarse substrates predominate in these reaches and spawning gravels and LWD are relatively scarce, limiting its potential suitability as coho salmon habitat. Slide Creek Dam blocks access to an additional 2.3 km (1.4 mi) of mainstem habitat in the North Umpqua River. The North Umpqua River upstream of Slide Creek Dam is a relatively high-gradient, confined reach that contains extremely limited spawning gravels and relatively little habitat for anadromous salmonids (Stillwater Sciences 2000).

Within the Action Area, ODFW's Rock Creek Diversion Dam and fish ladder currently prevent upstream passage of about 30-50% of adult coho salmon to more than 44.5 km (27.5 mi) of high-quality, low-gradient spawning and rearing habitat for coho salmon (D. Loomis, pers. comm., 2001). This figure was based on radiotelemetry studies and observations at the diversion facility. In addition, the facility prevents all upstream movement of juvenile salmonids, and prevents upstream passage of about 30-50% of summer steelhead, 10% of winter steelhead, over 90% of coastal cutthroat trout, and 10-30% of spring chinook salmon (D. Loomis, pers. comm., 2001). The amount of spawning and rearing habitat for species other than coho salmon that is currently less accessible due to the diversion dam has been estimated to be at least:

- 62.5 km (39 mi) for steelhead,
- 71.3 km (44.3 mi) for migratory coastal cutthroat trout, and
- 12.6 km (7.8 mi) for spring chinook salmon.

Downstream passage for juvenile salmonids

There are no listed salmonid species that currently occur upstream of Project dams, therefore the Project currently has no effect on downstream passage by listed salmonids.

3.3.4 Habitat Elements and Channel Conditions/Dynamics

NOAA Fisheries includes habitat elements and channel conditions and dynamics as properly functioning conditions pathways. Properly functioning indicators of habitat elements include substrate, LWD, pool frequency, pool quality, off-channel habitats, and "hot spots" and refugia. Properly functioning indicators of channel conditions and dynamics include width/depth ratio, streambank condition, and floodplain connectivity.

Geomorphic processes and channel morphology

In the North Umpqua River, historically low sediment supply (relative to drainage area), high transport capacity, and increased sediment supply under current conditions have limited the effects of Soda Springs Dam on channel morphology. Because the majority of the drainage area upstream of Soda Springs Dam is in the High Cascades/Surficial Deposits terrains, sediment loading at the dam site is naturally low relative to areas downstream. The confinement and steep slope of the North Umpqua River promoted naturally high levels of sediment transport, which led to a coarse bed with few potential locations for gravels to deposit. Sediment production has increased due to land use, particularly from tributaries, Highway 138, and the large 1964 landslide. This increase in production served to compensate for sediment trapped behind Soda Springs Dam.

Soda Springs Dam affects channel morphology by reducing coarse sediment supplied from the upper basin. High-frequency flows have been reduced, but low-frequency flows are essentially unaltered. This means that flows capable of transporting sediment still occur in the bypass reach resulting in bed coarsening, or even scour to bedrock.

Project dams and diversions have reduced the magnitude of 1.5-year recurrence interval flood events, while the magnitudes of larger events (> 5-year recurrence interval) have been unchanged. Reductions in high flows do not appear to have had morphological effects on Project bypass reaches. This is likely due to the unaltered magnitude of larger events, the cobble, boulder, and bedrock-dominated channel morphology of most bypass reaches, and reductions in sediment supply.

Sediment budget and substrate characteristics

Sediment input rates have been substantially reduced below Soda Springs Dam, particularly between the dam and Boulder Creek. Below Boulder Creek, bedload flux increases downstream with increased supply associated with sediment delivered from tributaries, the 1964 landslide, and Highway 138.

Analyses of bed mobility were conducted in the mainstem North Umpqua River to gain insight into potential dam-related effects on frequency of bed mobilization. Field investigations were conducted at the USGS Copeland gauging station, a site downstream of Soda Springs powerhouse with cobble-dominated, plane-bed channel morphology where peak flows have not been reduced. Coarse sediment supply to this site is reduced through capture at Soda Springs Dam and largely originates from the Boulder Creek watershed. Field measurements at the USGS Copeland Gage indicate that coarsening of the bed has likely occurred in the reach downstream of Soda Springs Dam. Because the bed would have been coarse before the Project was built, the dam has likely accentuated a naturally occurring condition.

In the Western Cascades terrain, channel morphology of larger mainstem reaches may have undergone changes in substrate characteristics (e.g., changes in size distribution), although the characteristic cobble-boulder, plane-bed morphology of these channels has not changed. In general, sediment transport capacity exceeds supply in these larger reaches, despite increased sediment delivery and decreased streamflow in some areas. Project dams, particularly those located near the mouths of tributary basins with relatively high sediment yields, block coarse sediment delivery to downstream areas, intensifying sediment-supply-limited conditions found in these reaches. The Project has affected both mainstem reaches of the North Umpqua River and Fish Creek in the Western Cascades terrain, as well as a portion of the Clearwater No. 2 reach that occurs within this terrain. Tributaries to the Lemolo No. 2 bypass reach that occur within the Western Cascades terrain have also experienced impacts from diversions into the Lemolo No. 2 waterway and increased mass wasting.

Project dams currently trap fluvially transported sediment, including up to 100% of bedload and up to 80% of suspended load, reducing the amount of sediment delivered to downstream reaches. A total of about 4.5 million m^3 of sediment has been deposited in Project impoundments between 1950 and 1996. Bedload delivery to reaches immediately downstream of Project dams has typically been eliminated; for example, bedload supplies have been reduced in the mainstem North Umpqua River from Soda Springs Dam to Boulder Creek by 95 to 100%.

The capture of gravel by the dams is partially compensated for by increased mass wasting associated with roads, timber harvesting, and waterway spills. Since 1950, landsliding frequency has increased by about 5-fold (or possibly greater), and associated sediment delivery to stream channels has increased by about 2- to 4-fold; the difference between these figures accounts for continued hillslope storage of landslide-generated sediment. This increase has occurred exclusively in the Western Cascades geomorphic terrain and is likely attributable to roads, timber harvesting, and Project facilities rather than to climatic change. Much of the anthropogenic increase in sediment input to low-order channels appears to have occurred between 1950 and 1966, a period of intensive timber harvesting and road construction and poor forest practices.

While much of the increase in hillslope sediment production has been caused by forest management activities, the Project has also increased hillslope erosion. Waterway failures, which are typically caused by landslides during storm events, usually cause immediate, uncontrolled spill out of waterways and onto adjacent hillslopes, causing substantial erosion. Waterway failures are most common along the Lemolo No. 2, Clearwater No. 2, and Fish Creek canals. Flume and waterway upgrades during the early 1980s have reduced the number of failures), although erosion impacts continue to occur. Erosion at the Lemolo No. 1 spillway has also contributed large amounts of sediment to the North Umpqua River.

Channel sediment storage

In the North Umpqua River basin, reductions in channel sediment storage have occurred in mainstem reaches below dams, where sediment delivery has been reduced relative to transport capacity, and in mid-order tributary channels where LWD is removed. Increases in channel sediment storage have occurred in parts of the watershed due to the 1964 flood and anthropogenic increases in mass wasting.

Because only frequent, low-magnitude peak flows have been reduced by the Project, bypass reaches continue to receive flows capable of transporting sediment, especially gravel and finer size classes. Therefore, in channels immediately downstream of Project dams, gravels are selectively transported from in-channel storage but are not replenished from upstream supplies, resulting in gravel depletion in these reaches. This process has likely caused coarsening and simplification of the particle size distribution downstream of Project dams, reducing availability of gravels and decreasing habitat suitability for some aquatic species. The degree to which bed coarsening and in-channel sediment storage depletion occurs typically decreases in a downstream direction as additional sources contribute bed material.

Dam-related effects on channel sediment storage have been partly counteracted by the 1964 flood, particularly in the Western Cascades terrain. In the mainstem North Umpqua River and large tributary channels downstream of Soda Springs Dam, sediment delivery associated with the 1964 flood increased the amount of sediment stored in gravel bars. Bars that could be detected on 1966 aerial photographs were large relative to channel width and were located in depositional sites associated with major river bends and bedrock outcrops. Increases in gravel bar size were localized, however, and most reaches of the mainstem and major tributary channels continue to be characterized by plane-bed and bedrock channel morphology with limited sediment storage. Gravel in these channels typically is not stored in bars, but rather as patches interspersed within a matrix of cobble-boulder substrate.

Land use impacts have altered sediment storage in tributary channels, particularly in the Western Cascades terrain portion of the watershed. Sediment input to low-order channels (first- and second-order) associated with mass wasting increases between 1950 and 1966 likely increased the amount of sediment stored in these smaller channels, particularly where LWD has not been removed. The residence time for sediment stored in small tributaries is typically long (the regional average for second- and third-order streams is 100–250 years [Benda 1994; O'Connor and Harr 1994]), suggesting that sediment currently stored in low-order channels as a result of increased mass wasting will likely supply elevated amounts of sediment to higher-order channels for several decades to come, even in the absence of further mass wasting.

While the amount of sediment stored in the smallest channels has increased, LWD removal has decreased sediment storage capacity in mid-order channels (third- and fourth-order), causing some areas to be scoured to bedrock and reducing habitat suitability for anadromous salmonids and other aquatic organisms. Sediment that had been stored for long periods by LWD jams in mid-order channels was likely rapidly released downstream in the 1960s and 1970s in areas where such jams were removed. The sediment release associated with LWD removal from mid-order channels would amount to a 10 to 25% increase over the long-term sediment yield, according to sediment budget calculations. Increased stream bank erosion following LWD removal would likely further increase sediment production in these channels. Mass wasting and bed and bank erosion in lower-order tributaries continue to provide sediment to mid-order channels, but sediment storage capacity in these channels has been reduced because of LWD removal and/or decreased recruitment.

Substrate

Because Soda Springs Dam currently represents the upstream extent of anadromous fish distribution, geomorphic changes currently affecting anadromous fish are confined to areas of the North Umpqua River basin downstream of Soda Springs Dam. In the mainstem North Umpqua River, the reduction of sediment delivery caused by Soda Springs Dam has reduced availability of spawning gravels, particularly in the reach from Soda Springs Dam to Boulder Creek, potentially reducing the spawning success of spring chinook salmon and steelhead. Coarse, stable bed materials used as cover during the winter by juvenile spring chinook and steelhead are abundant in the mainstem, and Soda Springs Dam may have contributed to the stability of these substrates through coarsening. This process may have had deleterious effects on anadromous fish such as Pacific lamprey that require finer bed materials.

In tributaries, LWD removal and associated loss of pool habitats, channel complexity, and reduced storage of gravel and organic matter have likely reduced habitat quality for anadromous fish. Scouring of mid-order channels to bedrock and shifts from forced pool-riffle to plane-bed morphology have likely degraded spawning and rearing conditions in the Steamboat Creek basin and other tributaries downstream of Soda Springs Dam.

Large woody debris

Habitat associated with LWD has likely been changed due to past removal of instream debris and reduced recruitment due to timber harvesting and the presence of streamside roads. Generally, LWD removal reduces channel roughness and increases stream power and decreases the availability of velocity refuge and overwintering habitat. Reduced sediment storage capacity reduces amount of gravels available to salmonids for spawning. LWD loading has been reduced by removal of LWD from stream channels, particularly in areas where streamside roads facilitated its removal, including along tributary streams and along the North Umpqua River adjacent to Highway 138. In addition, Project facilities have interrupted the downstream transport of LWD. Project dams and diversions temporarily or permanently trap LWD, and waterways and waterway maintenance roads intercept debris flows that may otherwise serve as an important mechanism for transporting LWD to larger channels.

Analysis of LWD data from 94 stream reaches throughout the North Umpqua River basin found that only 12 reaches (13%) currently meet or exceed USFS target conditions for LWD frequency of 50 pieces/km (80 pieces/mi) meeting a minimum size criteria of 60 cm (24 in) diameter and 15 m (50 ft) in length , suggesting that management disturbances have reduced LWD loading in many areas. These target conditions are especially relevant to lower-order stream channels (first- to fourth-order), where LWD frequency tends to be greater. LWD frequencies would be expected to be lower than 50 pieces/km (80 pieces/mi) in confined mainstem channels of the North Umpqua River where high flow events are powerful enough to transport even very large pieces of LWD.

Pool frequency and quality

Comparison of historical (pre-project) aerial photographs and surveys with current conditions suggests that pool frequency in the mainstem North Umpqua River downstream from Soda Springs has not been affected by the Project (Stillwater Sciences, unpubl. data). Based on habitat surveys conducted during the relicensing studies (PacifiCorp 1995), pool frequency for the reach of the mainstem North Umpqua River from the Soda Springs powerhouse to Steamboat Creek is 1.2 pools/mi observed (19 pools over 16 mi) (PacifiCorp 1995). Pool frequency in the Soda Springs bypass reach was 8.6 pools/mi (5 pools over 0.6 mi). All pools in the reach of the mainstem North Umpqua River from Soda Springs powerhouse to Steamboat Creek had measured depth greater than one meter (3.28 ft). In tributary reaches, the frequency and quality of pools have likely decreased in part due to reductions of LWD in these channels.

Off-channel habitat

In the North Umpqua River basin, off-channel habitat is naturally uncommon in the mainstem due to the confined nature of the channel, and more common in low-gradient tributaries, such as Rock Creek. Reservoirs such as Soda Springs may have reduced the availability of off-channel habitat in the mainstem North Umpqua River by inundating relatively uncommon alluvial reaches. Valley-bottom roads have a high potential for impacting channel morphology when road fill is located in the floodplain. Roads constructed within floodplains or adjacent to stream channels can directly alter interactions between stream channels and hillslope and riparian processes. Valley bottom roads are common in tributary subbasins and have likely reduced off-channel habitat to some extent.

Width/depth ratio

Processes related to timber harvesting and road construction, such as increased peak flows and simplification of channel morphology due to LWD removal, may lead to channel widening. In the South Umpqua River basin, Dose and Roper (1994) found that 13 of 14 tributaries within logged basins had significantly widened since the 1930s, compared to 1 of 8 tributaries with headwaters within wilderness areas. Retention of LWD in channels appeared to mitigate widening (Dose and Roper 1994). Channel widening can reduce habitat quality for anadromous fish by increasing solar radiation and stream temperatures and by decreasing a channel's ability to retain LWD. Small-scale, localized channel widening has been reported in tributaries in the Steamboat/Canton Creek basin and is likely associated with the 1964 flood, streamside timber harvest, and removal of LWD (USFS et al. 1994).

Streambank condition

Bank erosion is generally high in first- and second-order channels and low in fifth-order and higher channels that have banks primarily composed of bedrock. Streambank conditions in tributary subbasins are generally impacted by roads and forest management activities. Streambank conditions in Project-affected reaches are generally in higher-order channels with stable banks.

Floodplain connectivity

Throughout most of the North Umpqua River basin, streams are relatively confined and lacked extensive floodplains under pre-Project conditions. Unconfined channels are relatively uncommon in the Action Area. Floodplain habitat associated with unconfined alluvial reaches, which may be important to many aquatic species, has been reduced by inundation of such habitats by Lemolo, Stump, and Toketee lakes, and Soda Springs Reservoir.

3.3.5 Flow/Hydrology

NOAA Fisheries has identified flow/hydrology as a PFC pathway. Project operations on the North Umpqua River have affected three primary components of instream flows that have particular significance for lotic and riparian biota: baseflows, high flows, and ramping rates (defined below).

- *Baseflows*. Baseflows represent the discharge in a river that is not directly related to storms (the steady flows between storm events). Baseflows are often referred to as minimum instream flows for regulated streams. Baseflow levels influence the quality and quantity of stream habitats throughout much of the year, determining the amount of wetted stream channel area, influencing temperature and other water quality parameters, and potentially limiting habitat availability during low-flow periods.

- *High Flows*. Natural high flows occur in response to snowmelt runoff and rainstorms. Magnitude (expressed in this report in cubic meters per second [cms] and cubic ft per second [cfs]), frequency (how often a given flood magnitude occurs), duration (length of flood events), and seasonal timing are common descriptions of the high-flow regime. High flows influence geomorphic and ecological elements of stream channels by transporting and depositing fine and coarse sediments, preventing riparian encroachment and channel narrowing, affecting fish migrations, and maintaining connectivity between channels and floodplains. Floods of certain magnitudes have a geomorphic significance; for example, the bankfull discharge, which has an average recurrence interval of 1.5 years in many unregulated rivers, is considered the channel-forming flow in many systems.

- *Ramping Rates*. A ramping event is defined as a natural or human-induced event in which river discharge and water surface elevation increases or decreases. Hydroelectric Project operations influence the frequency, magnitude, timing, and rate of ramping events. Ramping rates are measured with reference to the water surface elevation (stage) and are often expressed as a vertical change in water level over a period of time, for example,15 cm/hr (6 in/hr) or 0.3 m/day (1 ft/day). The relationship between changes in discharge and changes in stage is strongly influenced by cross-sectional channel morphology; confined channels typically experience more rapid stage fluctuations than unconfined channels. Storm events cause natural flow changes, and the precipitation and runoff processes of a given watershed influence these rates. At hydroelectric projects, flows are often ramped in ways that exceed the rate, magnitude, and/or frequency of natural flow changes. In addition to causing increases or decreases in stage, flow changes alter the velocity, depth, and shear stress characteristics of rivers, altering physical habitat for aquatic species. Increases in stage (upramping) can potentially displace eggs, juveniles, or adults of aquatic species, increase turbidity as rising water mobilizes sediments, and alter other aspects of water quality such as temperature and dissolved oxygen. Decreases in stage (downramping) can strand eggs or juveniles of aquatic species along dewatered areas of the channel and can affect some water quality parameters. Ramping can also reduce benthic species diversity, density, and biomass by eliminating species less tolerant of flow fluctuations.

Baseflows, high flows, and ramping rates function differently and have different biological effects in different types of Project-affected stream reaches. There are two main types of Project-affected reaches in the Project area:

- *Bypass reaches* are reaches from which water is diverted for Project operations. Bypass reaches typically have a minimum flow release near the point of diversion. Flows in bypass reaches are determined by minimum flow releases at diversion dams, accretion flows from tributaries, and spill at dams when flows exceed diversion capacities. Most bypass reaches receive full river flow for several weeks annually when diversions are shut down for facilities maintenance. Bypass reaches occur in the North Umpqua River, Clearwater River, and Fish Creek.

- *Full-flow reaches* are those in which no diversion of flow occurs, but in which flows may be subject to ramping as a result of Project operations. Full-flow reaches along the North Umpqua River include the following: (1) Lemolo No. 2 powerhouse to Toketee Lake; (2) Toketee powerhouse to Slide Creek Dam, (3) Slide Creek powerhouse to Soda Springs Reservoir, and (4) the entire North Umpqua River below Soda Springs powerhouse. There are no full-flow reaches on the Clearwater River or Fish Creek.

The Project has altered baseflows, high flows, and ramping rates in Project-affected reaches. Changes to baseflows and high flows have mainly affected bypass reaches, while changes in ramping rates have altered hydrologic conditions in bypass reaches and full-flow reaches.

Baseflows

Under current conditions, the distribution of anadromous salmonid is restricted to downstream of Soda Springs Dam, so they have been affected by reduced baseflows only in the Soda Springs Bypass Reach. (Summer and winter baseflows downstream of Soda Springs Powerhouse are not significantly affected by the Project, as all flows used to generate power are returned to the North Umpqua River at Soda Springs Powerhouse.) Current minimum instream flows in the Soda Springs Bypass Reach are 25 cfs year-round. The 25 cfs minimum-flow release provides 32% of peak weighted usable area (WUA) for juvenile chinook salmon, 82% of peak WUA for juvenile coho salmon, and 65% of peak WUA for juvenile steelhead. The flows that were modeled in the analysis ranged from 15 to 300 cfs.

High flows

High flows currently occur in bypass reaches when runoff exceeds the storage and diversion capacity of Project facilities (spill events) or during planned or emergency shutdowns. Project operations have reduced low-magnitude, high-frequency floods in bypass reaches. Large-magnitude events, which have been more common since 1945 due to wetter climatic conditions, have been less affected by the Project because of the limited storage and diversion capacity of most Project facilities; only Lemolo Lake can store significant amounts of water. High-flow events in full-flow reaches are least affected by regulation because these reaches continue to receive the full water yield. The largest flood of record occurred in the North Umpqua River basin in December 1964, reaching a magnitude of 1,150 cms (40,700 cfs) at the North Umpqua River above Copeland Creek gauging station.

Flow fluctuations/ramping rates

Three types of Project operations cause ramping in Project-affected reaches: ramping at powerhouses to follow energy demands (load following), planned shutdowns of powerhouses for annual facilities maintenance, and unplanned (emergency) outages due to waterway failures, turbine or generator malfunctions, or other Project-related occurrences. Operators generally have substantial control over ramping related to peak energy production and facilities maintenance but do not have control over unplanned shutdowns. The full-flow reaches often experience daily ramping caused by load following, in which flow releases through powerhouses follow daily variations in power demand. In bypass reaches, ramping occurs during planned and unplanned shutdowns, which involve routing of flow from waterways into adjacent bypass reaches. These upramps in bypass reaches are followed by downramps when water is returned to canals and powerhouses are brought back into operation. Upramping and downramping during annual facilities maintenance are typically controlled by manual operation of spillgates, spillways, and/or valves.

Unplanned outages typically result in rapid flow increases and upramping at uncontrolled rates into bypass reaches to avoid forebay, waterway, and reservoir spills and to maintain adequate flow in downstream reaches. Unplanned outages are more frequent in winter, when storms and associated floods, debris flows, and tree falls are more common and when bypass reaches often already contain high natural runoff. The causes of unplanned outages include (in approximate order of frequency): equipment failures, problems with control or distribution lines (e.g., trees on powerlines), plugging of intakes with debris, lightning affecting lines or equipment, waterway failures (which are typically caused by storms and landslides), and other problems (forest fires, ice, human errors).

Under current conditions, anadromous salmonid distribution is restricted to downstream of Soda Springs Dam, and so are affected by ramping only in the Soda Springs Bypass Reach and in the North Umpqua River below Soda Springs Powerhouse. Ramping rates under historical conditions in reaches accessible to anadromous fish reflected the influences both of the High Cascades upper basin, where low ramping rates occurred, and of flashy, Western Cascades tributaries, in which higher ramping rates occurred during storms. Maximum reference condition ramping rates of 0.21 m/hr (0.7 ft/hr) (upramping) and 0.15 m/hr (0.5 ft/hr) (downramping) were recorded during the 1950 flood (prior to Project construction) at the North Umpqua River above Copeland Gage. Ramping rates downstream of Soda Springs Powerhouse are sometimes higher under recent (post-Project) conditions than those that occurred under historical conditions. Soda Springs Reservoir serves as a re-regulating facility that dampens the effect of ramping at upstream powerhouses. Ramping rates are attenuated by the time the river reaches the Winchester Gage and typically remain well below 0.03 m/hr (0.1 ft/hr). However, rates can be higher under some operational regimes. The North Umpqua River above Copeland Creek gauging station baseflow conditions of August 1996 showed discharge fluctuating 2.8 to 5.7 cms (100 to 200 cfs) within a few hours, often twice a day. Increased ramping also occurs in this reach during unplanned shutdowns; downramping rates of about 0.15 m/hr (0.5 ft/hr) were recorded in this reach during an emergency fire shutdown in August 1996 (North Umpqua River above Copeland Creek Gage).

Flow changes at Soda Springs powerhouse were voluntarily limited during the 1970s to less than 0.09 m/hr (0.3 ft/hr). Lower (more restrictive) ramping rates were adopted starting in the late 1980s and have remained in effect since then: 0.03 to 0.05 m/hr (0.1 to 0.15 ft/hr) between 17.0 and 24.1 cms (600 and 850 cfs);0.04 to 0.05 m/hr (0.12 to 0.18 ft/hr) between 24.1 to 41.0 cms (850 to 1,450 cfs); and 0.05 to 0.07 m/hr (0.17 to 0.24 ft/hr) above 41.0 cms (1,450 cfs). A one-foot maximum stage change per 24 hours was also adopted by PacifiCorp. From October 1987 to September 1991, 95% of flow fluctuations downstream of Soda Springs powerhouse were less than 0.06 m/hr (0.2 ft/hr); most of the higher ramping rates occurred during winter and late spring. However, ramping rates can exceed these guidelines during baseflow periods when unplanned shutdowns occur, such as during the emergency shutdown in August 1996.

Project-induced flow fluctuations increase the potential for the stranding of fish in Project-affected reaches. Stranding of juvenile salmonids in the North Umpqua River generally occurs in areas where low bedrock terraces tend to trap fish in small "potholes" as streamflows recede. In June, 2000, Project-related flow fluctuations were reported to result in the stranding of fry and juvenile salmonids in the Wild and Scenic River Reach of the North Umpqua River upstream of the mouth of Rock Creek over a 4 to 5 day period (Dose 2000). These flow fluctuations were related to unusually high energy demands in the Pacific Northwest and did not represent normal flow fluctuations. About 200 dead juvenile salmonids were reported in isolated pools and numerous live fish were seen in pools recently disconnected from the mainstem; identification to species was not possible due to the small size and deteriorated condition of the fish (Dose 2000). Following this event, PacifiCorp instituted voluntary ramping restrictions and no further stranding events have occurred since that time. Such ramping restrictions were incorporated into the SA as well.

3.3.6 Reservoir and Forebay Habitats

There are three reservoirs on the mainstem of the North Umpqua River: Lemolo Lake (419 ac [170 ha]), Toketee Lake (97 ac [39 ha]), and Soda Springs Reservoir (32 ac [13 ha]). None of these are currently accessible to anadromous fish; however, Soda Springs Reservoir will become accessible to anadromous fish under the terms of the SA. Soda Springs Reservoir is a low-volume impoundment that inundates about 1.9 km (1.2 mi) of the mainstem North Umpqua River. It has a surface area of about 13 ha (31 acres) and a residence time of less than two hours. Slide Creek Dam does not create a reservoir; the reach upstream of this dam is effectively a pool-like portion of the full-flow reach downstream of Toketee powerhouse.

Resident trout reside in all Project reservoirs and forebays. Brown trout (an introduced species) and rainbow trout - both of which are capable of preying on juvenile salmonids - also occur in Soda Springs Reservoir. The potential effects of predation on juvenile anadromous fish produced upstream of Soda Springs Reservoir following construction of fish passage facilities is discussed in Section 4.1.2.1.

3.3.7 Fish Populations

Native fish species

The distributions of fish populations in the basin are determined largely by natural and artificial barriers, human introduction of non-native fish, and suitability of habitat. Many types of natural barriers to resident and anadromous fish movement are distributed throughout mainstem and tributary reaches, and consist primarily of falls and cascades. Toketee Falls on the North Umpqua River represents the most downstream natural barrier to upstream movement of anadromous fish. Artificial barriers to fish movement consist primarily of dams and diversions associated with the Project as well as road/stream crossings that are inadequate for fish passage. Soda Springs Dam currently represents the farthest downstream barrier to upstream movement of anadromous fish in the mainstem North Umpqua River.

There are five species of anadromous fish in the North Umpqua watershed study area: chinook and coho salmon, steelhead, coastal cutthroat trout, and Pacific lamprey. The mainstem North Umpqua River is used primarily by spring chinook salmon and winter steelhead. Tributary streams are used primarily by summer steelhead, coastal cutthroat trout, coho salmon, and Pacific lamprey.

Between Soda Springs Dam and Toketee Falls, the North Umpqua River watershed is primarily inhabited by rainbow and brown trout. In the Fish Creek drainage, rainbow trout are the only confirmed resident fish species. Upstream of Toketee Falls, the watershed primarily supports populations of non-native fish, including brown trout, brook trout, and rainbow trout, and smaller populations of kokanee (landlocked sockeye salmon), tui chub, and bluegill.

Introduced fish species

Several species of introduced fish have become established in the Umpqua River basin. In the mainstem Umpqua River, striped bass, smallmouth bass, and American shad are common and are potential predators on and/or competitors with native fish species. Although rainbow trout and coastal cutthroat trout are native to the North Umpqua River downstream of Soda Springs Dam, hatchery-bred strains of these species have been stocked in the past. Cutthroat trout were stocked between 1961 and 1973, and catchable-size rainbow trout were stocked until 1997, when this planting program was ended to protect native cutthroat trout (Synthesis Report, Vol. 3, p. 2-14).

In the Project area, brown trout, brook trout, and rainbow trout were introduced several times from the 1900s through 1970s and have succeeded in establishing self-sustaining populations in various portions of the watershed. Stocking hatchery-produced trout into streams and lakes throughout the watershed was a fairly common practice between 1930 and 1975. Diamond Lake and Lemolo Lake contain substantial numbers of tui chubs, which are believed to have been introduced in the 1930s, and Lemolo Lake contains a population of kokanee (landlocked sockeye salmon) that were stocked in the mid-1900s.

The lower reaches of the North Umpqua River, as well as the mainstem Umpqua rivers are home to introduced piscivorous fish species such as brown trout, smallmouth bass, and striped bass, which have likely caused increased predation mortality on anadromous smolts migrating downstream from the North Umpqua River to the ocean. Mortality due to predation is size-dependent, with smaller fish that outmigrate at an earlier age being most vulnerable.

Striped bass were first recorded in the Umpqua River in 1934 (FCO and OSGC 1946) and are currently distributed from the mouth of the Umpqua River to 40 km (25 mi) upstream and in the estuary throughout the year (Bauer et al. 1979). Striped bass have much greater potential than smallmouth bass to prey on salmonids because their large size and their ability to actively feed in a range of water temperatures allows them to prey on salmonid smolts of varying size and outmigration timing. Striped bass have been documented as being important predators of salmonids in California’s Sacramento-San Joaquin river system (Thomas 1967); they are perhaps most effective predators of salmonid smolts during years of relatively low, clear water during spring outmigrations. The abundance of striped bass in the Umpqua River may have peaked in the 1940s and 1970s (D. Loomis, pers. comm., 1997); population estimates based on tag recoveries from 1972 to 1974 ranged from 43,000 to 73,800 fish (Bauer et al. 1979).

Smallmouth bass were first recorded in the Umpqua River in the 1970s following illegal introductions (Daily 1992). This species extends into the lower 3.2 km (2 mi) of the North Umpqua River, below Winchester Dam. Smallmouth bass are known to prey on salmonids under about 85 mm (3.3 in) length (Daily 1992). Smallmouth bass are most active at higher temperatures than preferred by salmonids and, in most years, after the majority of salmonid outmigrations have occurred (Daily 1992; D. Loomis, pers. comm., 1997), although they are likely active during Pacific lamprey outmigrations.

Brown trout in the North Umpqua River between Winchester and Soda Springs dams occasionally attain large sizes and likely prey on juvenile anadromous salmonids, although the magnitude of this effect is uncertain. The North Umpqua River's cold temperatures and lack of off-channel overwintering habitat may limit the size of resident trout, which may be displaced downstream during high flows once they are too large to use interstitial substrate cover. The cold temperatures in this reach also exclude warm-water species that prefer warmer water, such as smallmouth bass.

Juvenile salmonids may be experiencing increased interspecific competition for food in the Umpqua Estuary due to the presence of American shad and striped bass populations. Competition for food may be more intense in estuaries because a variety of fish species are spatially and temporally concentrated in this habitat and have similar diets (Fresh 1997). High dietary overlap between American shad and juvenile salmonids in estuaries has raised concern about the influence of this introduced species on salmonid declines (McCabe et al. 1983, as cited in Fresh 1997).

Hatchery influences

Wild stocks of salmonids may be adversely impacted by hatchery supplementation through increased competition during the juvenile rearing period and genetic changes resulting from interbreeding between wild stocks and out-of-basin hatchery stocks (Moyle et al. 1989). Interbreeding between wild and hatchery fish on natural spawning grounds may be a threat to the genetic integrity of wild salmonid stocks whether or not the hatchery stock is of native origin. Moyle et al. (1989) point out that hatcheries select for different traits than the natural environment, referred to as "domestication selection" due to rearing of fish under conditions of reduced predation, simplified habitat, artificial feeding, extremely high rearing densities, etc. Hatcheries may also be subject to disease outbreaks, water contamination, and other problems. Hatchery-produced juveniles residing in rivers for an extended period may compete with wild juvenile salmonids for rearing space and food resources. Timing the release of hatchery smolts to avoid competition with juveniles can minimize these effects (Nicholas 1988). Hatchery stocking is often associated with increased fishing pressure, potentially causing increased harvest of wild fish (Barnhart 1991).

ODFW currently stocks Project forebays with catchable rainbow trout. Management of spring chinook salmon, coho salmon, summer steelhead, winter steelhead, coastal cutthroat trout, and other species is directed by the North Umpqua River Fish Management Plan (ODFW 1986) and ODFW's Native Fish Conservation Policy. On November 8, 2002, the Oregon Fish and Wildlife Commission culminated a year of review and adopted the newly written Native Fish Conservation Policy to guide work toward recovery and sustainability of native fish species.

The final adopted policy includes, but is not limited, to the following: identifies a primary purpose to remove fish species from ESA lists and avoid future listings; focuses on the sustainability of naturally produced native fish and identifies naturally produced fish as providing the foundation for hatchery programs and fisheries; and provides a basis to manage hatcheries, fisheries, habitat, predators, competitors, and fish pathogens in balance with sustainable naturally produced native fish.

The Oregon Fish and Wildlife Commission also adopted an order that requires staff to propose salmon and steelhead species management unit designations by December 2003 and to review all ODFW's current fish management administrative rules for consistency with the new policy by September 2003.

The North Umpqua River Fish Management Plan includes placing a "strong emphasis on wild fish management (options 1 and 2 of the Wild Fish Policy), which implies a strong emphasis on habitat protection and enhancement. Although harvest regulation and appropriate use of hatchery fish are important to wild fish management, the maintenance of diverse habitats is more important. Without habitats capable of supporting natural life histories, wild fish could not persist regardless of how harvest was regulated or how hatcheries were operated." The main habitat objectives identified in the plan include (1) minimizing habitat losses, and (2) enhancing fish habitat.

FERC will use the North Umpqua River Fish Management Plan as part of the State of Oregon's comprehensive basin plan for purposes of the FPA, Section 10(a) evaluation of the Project's new license application. Also, the North Umpqua Fish Management Plan, which currently applies only to areas downstream of the dam, would be amended if fish passage facilities are constructed at Soda Springs Dam.

3.3.8 Summary

Some habitat requirements of the OC coho salmon ESU are not being met under the environmental baseline. Conditions within the Action Area, including some influenced by past or ongoing Project effects, have contributed to the current status of the ESU. Environmental baseline conditions in the Action Area would have to improve to meet those biological requirements. Any further degradation or delay in improving of these conditions might increase the amount of risk that the listed ESU presently faces under the environmental baseline. Table 6 displays a summary of the relevant factors discussed in the above sections, based on the *Matrix of Pathways and Indicators* (MPI) described in NMFS (1996).

Table 6. Status of environmental baseline conditions in the Action Area, as defined by NOAA Fisheries' Matrix of Pathways and Indicators (NMFS 1996, 1999; Section 3.2) and applicable ODEQ water quality criteria (where indicated).

PFC Pathway	PFC Indicator	Properly Functioning Conditions	Current Baseline Conditions in the Action Area[1]	Status
Water Quality	Temperature	ODEQ criteria: *Spawning* (applies from spawning to fry emergence) = 12.8°C 7DMX2 *Cold-water* (applies throughout the year) = 17.8°C (64°F)	Under baseline conditions, ODEQ cold water criteria are exceeded during summer months; however, due to coho's periodicity, such exceedances do not adversely affect coho salmon. Raised temperatures are not caused by Project operations. Rather, water temperatures above the Project are elevated, and the Project does not significantly contribute to increased temperatures.	Properly functioning (for coho)
	Sediment/ Turbidity	< 12% fines in gravel, low turbidity	Turbidity and embeddedness of substrate is generally very low in the North Umpqua River. Project canal and flume failures have occasionally caused short-term elevated turbidity, but usually occur during winter high flows when water would naturally be turbid. [3.3.2]	Properly functioning
	Chemical Contamination/ Nutrients	low levels of chemical contamination from agricultural, industrial and other sources, no excess nutrients, no CWA 303(d) designated reaches	Chemical contamination and nutrient levels are low in the Action Area. There is no evidence that the Project is increasing nutrient concentrations or chemical contamination in the Action Area. No 303(d) designated reaches occur in the Action Area [3.3.2]	Properly functioning
	Dissolved Oxygen	ODEQ criteria: salmonid spawning and rearing >6.0 mg/l, or no change from background	Dissolved oxygen concentrations generally exceed >6.0 mg/l, and rarely fall below ODEQ criteria. [3.3.2]	Properly functioning
	Total Dissolved Gases (TDG)	ODEQ criteria: Shall not exceed 105% in waters less than 2 ft deep, or 110% in waters more than 2 ft deep	TDG concentrations meet ODEQ criteria downstream of Soda Springs Dam in reaches accessible to anadromous fish. ODEQ criteria are exceeded at Lemolo Nos. 1 and 2, and Clearwater No. 2 powerhouse; these reaches are upstream of current and historical anadromous fish distribution. [3.3.2]	Properly functioning
Habitat Access	Physical barriers	Any man-made barriers present in the watershed allow upstream and downstream passage at all flows	The Project's Soda Springs and Slide Creek dams currently block access to 6.6 mi and 1.2 mi (10.6 and 1.9 km) of historical spawning and rearing habitat for certain anadromous salmonids (excluding coho salmon). ODFW's Rock Creek Diversion Dam (non-Project related) is a partial barrier, limiting access to 27.5 mi (44.5 km) of coho salmon habitat. [3.3.3]	Not properly functioning (coho salmon)
Habitat Elements	Substrate	Dominant substrate is gravel or cobble (interstitial spaces clear) or embeddedness <20%	Embeddedness is generally low and gravel/cobble substrates are available. Project dams have reduced bedload supplies in the mainstem North Umpqua River from Soda Springs Dam to Boulder Creek by 95-100%. Project effects on bedload are less evident downstream of Boulder Creek due to increased supply from tributaries. [3.3.4]	At risk
	Large Woody Debris	>80 pieces/mile >24" diameter >50 ft length	Project dams interrupt LWD supply, but have not likely appreciably reduced frequency and loading of LWD in the Action Area due to high transport capability in affected reaches. Non-project-related management disturbances have reduced LWD loading throughout the Action Area. Over 90% of the reaches in the Action Area do not meet PFC target, but this is not due to Project effects [3.3.4]	Not properly functioning

PFC Pathway	PFC Indicator	Properly Functioning Conditions	Current Baseline Conditions in the Action Area[1]	Status
	Pool Frequency	for channels 100 ft wide, 18 pools per mi	Pool frequency in Project-affected reaches is less than 18 pools/mile. There is no evidence that the Project has substantially affected pool frequency. [3.3.4]	Not properly functioning
Habitat Elements (continued)	Pool Quality	pools >1 meter deep (holding pools) with good cover and cool water, minor reduction of pool volume	All pools in mainstem North Umpqua in the Action Area have depth >1 meter. There is no evidence that the Project has substantially affected pool quality. [3.3.4]	Properly functioning
	Off-channel Habitat	backwaters with cover, and low energy off-channel areas	Off-channel habitat is naturally uncommon in the mainstem North Umpqua River due to the confined valley. There is no evidence that the Project has affected off-channel habitat, except for inundating 1.2 mi (1.9 km) of potential habitat under Soda Springs Reservoir. [3.3.4]	At risk
	Refugia	habitat refugia exist and are adequately buffered; existing refugia are sufficient in size, number, and connectivity to maintain viable populations or subpopulations	There are Northwest Forest Plan Tier 1 key watersheds in the Action Area (Steamboat Creek basin), providing habitat refugia. [3.3.1]	Properly functioning
Channel Conditions and Dynamics	Width/Depth Ratio	<10	There is no inventory of width/depth ratios available for Project-affected reaches, apart from inundating some reaches with reservoirs.	Unknown
	Streambank Condition	>90% stable	Streambanks in Project-affected reaches are considered very stable. [3.3.4]	Properly functioning
	Floodplain Connectivity	off-channel areas are frequently hydrologically linked to main channel; overbank flows occur and maintain wetland function, riparian vegetation and succession	Off-channel and floodplain habitats are naturally uncommon in the mainstem North Umpqua River due to its confined valley. Valley-bottom roads occur along many tributaries and may affect floodplain connectivity in these areas. The Project is not believed to substantially affect floodplain connectivity. [3.3.4]	At risk
Flow/ Hydrology	Change in Peak/Base Flows	watershed hydrograph indicates peak flow, base flows, and flow timing characteristics comparable to an undisturbed watershed of similar size, geology and geography	The Project reduces baseflows in project-affected reaches, however, such reaches do not contain listed coho salmon. Peak flows of >5-year intervals are relatively unaffected. The Project alters seasonal flow patterns in reaches upstream of Soda Springs powerhouse. [3.3.5]	Not properly functioning
Watershed Conditions	Road Density and Location	<2 mi/mi^2, no valley bottom roads	Average density of all roads is about 4 mi/mi^2. Only a small proportion of the roads in the Action Area are related to the Project; USDA Forest Service roads make up a majority of the roads in the Action Area. [3.3.1]	Not properly functioning
	Disturbance History	<15% ECA with no concentration of disturbance in unstable or potentially unstable areas, and/or refugia, and/or riparian area	Project dams are situated in relatively stable river channels. Some Project roads (e.g., Burma Road) are located on relatively steep inner gorge slopes. Percent of watershed disturbed is unknown. [3.3.1]	Undermined
	Riparian Reserves	the riparian reserve system provides adequate shade, large woody debris recruitment, and habitat protection and connectivity in all subwatersheds	Riparian reserves in the Action Area are fragmented and provide incomplete protection of habitat along mainstem North Umpqua and tributaries because of past logging, roads, and Project waterways and diversions. Northwest Forest Plan protections exist on Federal lands in the Action Area. [3.3.1]	At risk

- Numbers in brackets represent corresponding section of the biological opinion where more detailed information on the subject can be found.
- 7DMX = the seven-day rolling average of the daily maximum temperature.

4. EFFECTS OF THE PROPOSED ACTION ON LISTED AND PROPOSED ANADROMOUS SALMONIDS AND CRITICAL HABITAT

4.1 Effects of the Proposed Action on Properly Functioning Conditions in the Action Area

This section includes an analysis of the direct and indirect effects of the proposed action on listed coho salmon and their habitats.

4.1.1 Effects of the Proposed Action on Water Quality

4.1.1.1 Effects of the Proposed Action on Temperature

The effects of the Project on water temperatures under current flow management regimes are described in Section 3.4.2. Under the proposed action, minimum flows will be increased in all three bypass reaches that will be accessible to anadromous fish. These flow increases will reduce summer water temperatures in the Slide Creek and Fish Creek bypass reaches, which is expected to improve spawning and rearing habitat quality for anadromous salmonids over current conditions. In the very short Soda Springs bypass reach (which is currently accessible to anadromous fish), increased minimum flows would slightly increase summer temperatures by diluting cold spring water that currently predominates because of flow diversions.

The proposed action includes funds for acquiring riparian conservation easements on tributary streams where high summer water temperatures may be limiting habitat quality for rearing anadromous salmonids.

Potential temperature effects on coho salmon upstream migration and spawning
Adult coho salmon are in the Action Area from October through December. Adult migration may occur from October through December. Spawning may occur from mid-October through the end of January.

Warm water temperatures are not expected to occur during adult migration and spawning. Under the proposed action, Project operations may reduce winter water temperatures in Fish Creek, which may become accessible to coho salmon under the proposed action. Adult coho salmon will not be exposed to elevated summer temperatures, but project operations may decrease temperatures in the winter as described below.

The lower lethal temperature for coho salmon is reported by Bell (1991) to be 0°C (32°F) (life stage unspecified). Bell (1991) shows temperatures between 7.2° and 15.6°C (45° and 60°F) to be suitable for adult upstream migration. For spawning, Bell (1991) show temperatures from 4.4° to 9.4°C (40° to 49°F) to be suitable. Adult coho salmon in Oregon have been observed spawning at temperatures as low as 2.5°C (36.5°F) (Burner 1951). Bell (1991) notes that spawning of anadromous salmonids may cease if temperatures drop to a level that is near or below the lower tolerance range.

Under the proposed action, the lowest predicted minimum temperatures for reaches that would become accessible to coho salmon range from 1.1° to 4.1°C (34° to 39.4°F). The effect of the Project on these temperatures is expected to be minimal; modeling of the no-project alternative suggested that a minimum temperature of 1.3°C would occur in Fish Creek in January, which is only 0.2°C above the predicted minimum temperature under the proposed action. It is possible that coho salmon could be affected by exposure to temperatures that may occur in Fish Creek, depending on the temperature and the duration of exposure. The coldest temperatures in the Action Area are expected in Fish Creek. Results from SNTEMP modeling suggested that if the Project diverted less water (increasing flows in the Fish Creek bypass reach), average daily minimum water temperatures near the lower lethal limit for coho salmon would still occur intermittently for a week or more in the lower Fish Creek bypass reach during the coldest periods of winter (PacifiCorp 1995, Vol. 24, Attachment 5.2-3). The effects of intermittent exposure to low temperatures on adult coho salmon are uncertain, but would likely depend on the exposure temperature, duration of exposure, and availability of temperature refugia. Coho salmon are not expected to use Fish Creek as spawning and rearing habitat in great numbers due to its relatively high confinement, lack of spawning gravel and LWD, and because most of the population currently spawns in lower elevation tributaries within the watershed. Cold water temperatures in Fish Creek are therefore not expected to be an important factor limiting coho salmon populations in the basin under the proposed action. If coho salmon are found to make extensive use of Fish Creek after fish passage facilities are provided at Soda Springs Dam, there is the possibility that low temperatures may reduce habitat suitability for the species. The potential sublethal effects of exposure to low temperatures on adult coho salmon in Fish Creek could include cessation of spawning or reduced survival of eggs (Bell 1991). The extent to which these effects may occur in the Project area under the proposed action is unknown.

Potential temperature effects on coho salmon egg incubation and alevin development
Incubation of coho salmon in the North Umpqua River may extend from mid-October through mid-April, and fry emergence may extend through the end of April (ODFW 2002). Recommended water temperatures for coho salmon egg incubation range from 4° to 12.8°C (PacifiCorp 2002a). Eggs develop normally at lower temperatures if initial development has progressed to where the eggs are tolerant of cold (Reiser and Bjornn 1979). Beacham and Murray (1990), compiling data from Velsen (1987) and additional sources, noted that coho salmon are apparently adapted to tolerating relatively low water temperatures during incubation, and showed the highest survival rates of all five Pacific salmon species at incubation temperatures of 1.5°C (34.7°F). Bell (1991) shows a lower threshold of 4.4°C (40°F) for coho salmon hatching. Bell (1991) notes that, during the first half of the incubation period, temperatures that are lowered from the lower tolerance range result in increased mortality, and a sudden drop in temperatures during this stage can cause excessive mortality.

Under the proposed action and post-anadromous-fish-passage flows, the 12.8°C ODEQ spawning temperature criteria (which applies from spawning to fry emergence) would not be exceeded (PacifiCorp 2002a).

Potential temperature effects on coho salmon freshwater rearing and outmigration

Coho salmon typically rear for a year in fresh water; therefore, they may be present in the Action Area during any month of the year. Under the proposed action, coho salmon distribution may expand upstream of Soda Springs Dam up to Slide Creek Dam and the Fish Creek obstacle. Under the proposed action and post-anadromous-fish-passage flows, temperature criteria for cold-water (i.e., rearing, outmigration) would be exceeded only in the Fish Creek bypass reach in July and August.

Juvenile coho appear to prefer temperatures of 10° to 15°C (50° to 59°F) (Hassler 1987), although Brett (1952) cites a narrower preferred range of 12° to 14°C (53.6° to 57.2°F) (Brett 1952). Brungs and Jones (1977) reported growth of juvenile coho at temperatures from 5° to 17°C (41.0° to 62.6°F). High growth rates were observed by Stein et al. (1972) at temperatures from 9° to 13°C (48.2° to 55.4°F). Growth may increase with higher temperatures as long as food supplies are not limiting; however, increases of only 4°C (39.2°F) have been shown in laboratory streams to decrease productivity for coho salmon where food is limiting (Hughes and Davis 1986).

In tributaries of the North Umpqua River, summer water temperatures can approach or exceed the upper lethal temperature of 25°C (77°F) for juvenile coho. Brett (1952) found that exposure to temperatures in excess of 25°C (77°F) or a quick rise in temperature from less than 20° to 25°C (68° to 77°F) resulted in a high mortality rate. High water temperatures that are below those considered to be lethal may also result in negative impacts to rearing coho (e.g., low growth rates). Stein et al. (1972) reported that growth rate in juvenile coho salmon slows considerably at 18°C (64.4°F), and Bell (1973) reported that growth of juvenile coho ceases at 20.3°C (68.5°F). Decreases in swimming speed may occur at temperatures over 20°C (68°F) (Griffiths and Alderdice (1972). During smolting, juvenile coho are very sensitive to increases in temperature. Wedemeyer et al. (1980) reported that smoltification and the onset of desmoltification may accelerate at temperatures over 10°C (50°F) and recommended that water temperatures during the smolt period remain below 12°C (53.6°F) to prevent shortened duration of smoltification, onset of desmoltification, and increased incidence of infection and disease.

In general, the proposed action will reduce stream temperatures in stream reaches accessible to coho salmon by increasing minimum instream flows over current conditions; in other reaches temperature regimes will remain similar to those found under current conditions.

Under current diversion rates, average daily maximum water temperatures in August may reach over 20°C (68°F); however, water temperatures would be about the same even under undiverted conditions. Under the proposed action, the Project will not divert water at the Fish Creek diversion in the summer months when discharge is <130 cfs. Temperatures may be reduced from current baseline by about 0.2°C in August as a result of this action, but would be nearly identical to those expected under undiverted conditions, and would still exceed rearing temperature criteria for coho salmon in August (PacifiCorp 2002a). Coho salmon will have access to the Slide Creek bypass reach upstream of the mouth of Fish Creek under the proposed action, but not many are expected to spawn in this reach due to its lack of spawning gravels and confinement.

Water temperatures in the Slide Creek bypass reach are expected to decrease under the proposed action, compared to the temperatures observed during the base period (PacifiCorp 2002a). Under current diversion rates, average daily maximum water temperatures in August reach approximately 18°C (64°F). Under the proposed action, temperatures in the Slide Creek bypass reach would decrease by more than 1.6°C, therefore reaching no more than 17.1°C during the same time period. Increased instream flows in the Slide Creek bypass reach are expected to reduce water temperatures below the 17.8°C water temperature criterion for rearing during the period from May to mid-October.

Water temperatures in the presently-accessible Soda Springs bypass reach, and downstream from the Project, presently achieve the 17.8°C water temperature criterion for rearing during the period from May to mid-October (PacifiCorp 2002a).

4.1.1.2 Effects of the Proposed Action on Turbidity and Suspended Sediment

The continued presence of the hydroelectric project may cause turbidity in the following ways:

- High flow events resulting from project operations may suspend and transport fine sediments and organic material,
- canal overflows and failures may result in pulses of turbidity from fine sediment input, or
- the canal may undercut the toes of marginally-stable slopes and trigger landslides that enter the river.

The potential effects of the Project on turbidity under current conditions are described in more detail in Section 3.4.2. Turbidity in the North Umpqua River is generally very low and determined to meet properly functioning conditions under the environmental baseline. Under the proposed action, the effects of the Project on turbidity are expected to be reduced through implementing measures to reduce erosion along project waterways. Ramping rate restrictions would reduce the magnitude of turbidity that occurs during unplanned shutdowns. In addition, project maintenance activities will be scheduled to occur during the natural high-flow period of the hydrograph when possible, reducing the frequency of project-related turbidity pulses during periods when flows would be low and water clarity generally high.

Proposed construction and enhancement projects included in the proposed action have the potential to cause temporary increases in turbidity. Construction and implementation plans for each activity will require NOAA Fisheries approval to ensure that standard best-management practices (such as erosion control and in-water work windows) and other measures to reduce impacts to salmonids and other aquatic species. Increases in turbidity associated with instream activities are expected to be short-term in nature, and are not anticipated to result in short-term mortality or long-term adverse effects on listed or proposed anadromous salmonids or the ecosystems upon which they depend.

4.1.1.3 Effects of the Proposed Action on Nutrients

Section 3.4.2 describes potential effects of the Project on nutrient concentrations in project-affected reaches. Studies conducted in 2000 and 2001 did not indicate that the Project is increasing nutrient concentrations downstream of Soda Springs powerhouse (Eilers and Raymond 2001). Nutrient levels in the North Umpqua River are generally very low and determined to meet properly functioning conditions under the environmental baseline. The proposed action is not anticipated to change these conditions. Under the proposed action, anadromous salmonids will be able to regain access to historical spawning reaches following construction of fish passage facilities at Soda Springs Dam. This will result in increased input of spawned-out salmonid carcasses and ocean-derived nutrients to these reaches compared to current conditions. This increase represents a restoration of a natural ecological process and is not expected to result in any adverse impacts to anadromous salmonids.

By substantially reducing anadromous salmonid access to the Rock Creek basin, and thus reducing the transfer of biomass and nutrients from the sea to these freshwater habitats, the Rock Creek Hatchery Diversion Dam may have reduced productivity of streams in this basin from historical conditions. Smaller tributary streams favored by coho salmon and coastal cutthroat trout for spawning and rearing typically show low levels of primary production during late autumn and winter because of heavy shading by stream canopies, low water temperatures, and frequent high flows (Bilby and Bisson 1992, as cited in Bilby et al. 1996). Salmonid carcasses have been found to substantially enrich carbon and nutrient cycles in the vicinity of spawning areas (Kline et al. 1990; Minshall et al. 1991; Bilby et al. 1996). Organic matter derived from salmonid eggs and carcasses is incorporated into the stream biota through direct consumption of eggs and carcasses by juvenile salmonids and macroinvertebrates (as well as numerous terrestrial wildlife species); and by sorption onto the streambed substrate of dissolved organic matter released by decomposing carcasses (Bilby et al. 1996). An increase in the abundance and distribution of anadromous salmonid carcasses in the Rock Creek basin should improve juvenile rearing habitat for coho and chinook salmon, steelhead, and coastal cutthroat trout by increasing the amount of nutrients in these streams. Bilby et al. (1998) found that age 0+ coho salmon and age 0+ and 1+ steelhead juvenile rearing densities increased following the addition of salmonid carcasses to small streams in southwestern Washington. In their study, the stomach contents of fish in the streams to which carcasses were added consisted primarily of salmon eggs and carcass flesh when the carcasses were present. They suggest that the eggs and carcasses of adult salmon may provide a very important resource during a period when other food items are often scarce.

4.1.1.4 Effects of the Proposed Action on Chemical Contamination

Chemical contamination concentrations in the North Umpqua River are generally very low and determined to meet properly functioning conditions under the environmental baseline. There is no evidence that the Project results in chemical contamination in the Action Area and no reason to anticipate that this will change under the proposed action. NOAA Fisheries must approve construction plans to ensure that best management practices will be used during construction of fish passage facilities and enhancement activities to reduce the potential for chemical contamination to occur. Water quality issues such as the potential for chemical contamination will also be addressed through the 401 certification process.

4.1.1.5 Effects of the Proposed Action on Dissolved Oxygen

The ODEQ criteria for dissolved oxygen is >6.0 mg/l (ppm) in streams used for salmonid spawning and rearing, or no change from background concentrations (ODEQ 1996). Section 3.4.2 describes dissolved oxygen concentrations in the Action Area under current project operations. Dissolved oxygen concentrations in stream reaches, reservoirs, and forebays associated with the Project are generally within the range suitable for anadromous salmonids, as described by Davis (1975), as well as within ODEQ water quality criteria for both water column and intergravel DO. The Action Area meets properly functioning conditions for DO under the environmental baseline and is expected to meet properly functioning conditions under the proposed action. Under the proposed action, increased instream flows are expected to increase DO concentrations in these bypass reaches.

4.1.1.6 Effects of the Proposed Action on Gas Supersaturation

The ODEQ criteria for TDG are that it shall not exceed 105% in waters less than 2 ft deep, or 110% in waters more than 2 ft deep (ODEQ 1996). Gas supersaturation caused by the Project is described in Section 3.4.2. Measurements of TDG concentrations downstream of Soda Springs Dam (i.e., in reaches currently accessible to anadromous fish) are generally within applicable ODEQ water quality criteria during normal project operations.

Total dissolved gases were measured during the periodic water quality surveys in the Project area from June 1992 to September 1994. Measurements of TDG concentrations yielded a range of values from 94% to 121% saturation (values were most often between 100% and 105%). Most of the higher measurements occurred during normal project operations at powerhouses that would not be accessible to anadromous fish under the proposed action (i.e., Lemolo Nos. 1 and 2, Clearwater Nos. 1 and 2). Measurement of TDGs during annual facilities maintenance flow releases at project facilities indicated that during upramping, TDG concentrations remained below 110% saturation at most sampling sites in bypass reaches (PacifiCorp 1996). Upramping rates did not appear to influence TDG concentrations. The Action Area meets properly functioning conditions for TDGs under the environmental baseline and is expected to meet properly functioning conditions under the proposed action. Under the proposed action, TDG concentrations related to Project operations are not expected to be harmful or change substantially in reaches accessible to anadromous salmonids.

4.1.2 Effects of the Proposed Action on Habitat Access and Physical Barriers

Background

Features associated with the North Umpqua Hydroelectric Project currently block upstream passage of anadromous salmonids. Section 3.4.3 describes existing barriers to upstream movement of coho salmon in the Action Area that are related to the Project. Soda Springs Dam blocks access to about 10.6 km (6.6 mi) of stream reaches for anadromous fish, including 5.5 km

(3.4 mi) in the North Umpqua River and 5.2 km (3.2 mi) in Fish Creek. The proposed action will provide upstream and downstream fish passage at Soda Springs Dam in Year 7 of the new license. Slide Creek will form the upstream-most barrier to anadromous fish migration following the construction of fish passage facilities at Soda Springs Dam.

The proposed action includes the following measures to improve habitat connectivity for anadromous salmonids in the Action Area:

- Providing fish passage at Soda Springs Dam,
- upgrading the Rock Creek Hatchery Diversion Dam to improve upstream fish passage, and
- long-term monitoring and predator control plan for Soda Springs Reservoir.

4.1.2.1 Anticipated Effects of Providing Fish Passage at Soda Springs Dam

Potential effects of the proposed action on upstream migration, spawning, and incubation of coho salmon

Installing a fish ladder at Soda Springs Dam would provide coho salmon with access to at least 10.6 km (6.6 mi) of additional stream reaches in the mainstem North Umpqua River and possibly Fish Creek. Under the proposed action, coho salmon will be able to access areas upstream of Soda Springs Dam that were historically available as spawning and rearing habitat prior to the construction of the Project.

Coho salmon historically migrated upstream in the North Umpqua River at least up to Fish Creek (PacifiCorp 1995, Vol. 25), and small numbers of coho salmon likely used the lower portion of Fish Creek. Under current conditions, coho salmon in the basin are most often found in lower-gradient reaches of tributaries and in lower-elevation tributary basins. Coho salmon are usually found in streams with gradients less than 3% and generally do not spawn and rear in mainstem habitats as often as in tributaries, although mainstem spawning has been observed in the North Umpqua River upstream to Soda Springs Dam. Because of their current distribution and habitat preferences, the propensity of coho salmon to use fish passage facilities at Soda Springs Dam remains uncertain. Coho salmon are typically dependent on the availability of low-velocity habitats for overwintering habitat and tend to prefer instream cover provided by LWD, which is limited in the mainstem North Umpqua River and in Fish Creek below the natural obstacle. Of the project-affected reaches that will be accessible to coho salmon, the Soda Springs and Slide Creek bypass reaches are expected to be the most suitable for coho salmon, but would still be expected to provide only low suitability spawning and rearing habitat for coho salmon. Fish Creek generally has higher gradients and may be less suitable for coho salmon than these mainstem North Umpqua River reaches.

Under the proposed action, fish passage facilities would be constructed at Soda Springs Dam and would be tested and functioning by the seventh anniversary of the new license. This measure would restore coho salmon access to historically accessible reaches of the mainstem North Umpqua River between Soda Springs Dam and Slide Creek Dam and to the Fish Creek basin.

Migration and spawning of adult coho salmon that use fish passage facilities at Soda Springs Dam under the Proposed Action may be affected by:

- Migration delays at (1) the Slide Creek Powerhouse tailrace (because of false attraction flows), (2) the fish ladder at Soda Springs Dam;
- injury or mortality associated with upstream passage at Soda Springs Dam; redd dewatering or stranding resulting from water level fluctuations in Soda Springs Reservoir;
- displacement, redd dewatering, or stranding resulting from frequent flow fluctuations in Slide Creek full-flow reach;
- project effects on water temperature, dissolved oxygen, and other water quality characteristics that would influence spawning and incubation; and
- capture of spawning gravel by Project dams.

The proposed action contains the following measures to minimize potential impacts associated with adult fish passage at Soda Springs Dam:

- Tailrace barriers at Soda Springs and Slide Creek powerhouses are expected to minimize injury or delay of anadromous salmonids that may be associated with the tailrace;
- design of adult fishways requires NOAA Fisheries approval to ensure that attraction flows and general ladder design meets NOAA Fisheries' fish passage criteria such that the potential for delay and injury of migrating adults will be negligible.
- Further, PacifiCorp should develop an operational and maintenance plans for fishways that will ensure that the fishways are operated and maintenance occurs on a schedule and in a manner that ensures continued accessibility and negligible delay and injury.
- spawning habitat enhancements in mainstem reaches (e.g., spawning gravel enhancement) should increase the amount of available spawning habitat for coho salmon;
- restrictions on ramping rates in the Wild and Scenic River reach downstream of Soda Springs powerhouse will reduce the potential for redd dewatering and stranding;
- studies will be conducted to evaluate the effects of ramping and emergency shutdowns on anadromous salmonids in the Slide Creek full-flow reach, including the upstream end of Soda Springs Reservoir where coho salmon may be most likely to spawn; if migration or spawning are adversely affected by ramping rates, PacifiCorp should operate the Toketee powerhouse to reduce ramping rates;
- if a bypass valve is needed to reduce impacts on aquatic resources in the Slide Creek bypass reach during emergency shutdowns, PacifiCorp should install such a valve or should propose alternative mitigation measures to achieve the same result;
- increased minimum flows should ensure that water quality remains within a range that is suitable for coho salmon migration, adult holding, and incubation.

Effects of the proposed action on rearing and downstream passage for juvenile coho salmon
Fish screens at the bypass facility are expected to reduce injury or mortality during downstream passage of adult and juvenile coho salmon, and modifying the Soda Springs Dam spillway should reduce injury or mortality associated with downstream passage of adult and juvenile coho salmon passing over the spillway.

Juvenile coho salmon typically spend a year in fresh water before outmigrating to the ocean; therefore, they may be found in accessible reaches throughout the year. Effects of the proposed action on rearing habitat quality above Soda Springs Dam are described in Sections 4.1.1 (water quality), 4.1.3 (habitat elements and channel conditions), and 4.1.4 (flows and hydrology). In addition to rearing in lotic habitats, coho salmon may also rear in Soda Springs Reservoir.

The degree to which coho salmon might use Soda Springs Reservoir as juvenile overwintering habitat is unknown. Although most coho salmon rear in streams, juveniles in some areas are known to migrate from streams to lakes for rearing (Godfrey 1965, as cited in Sandercock 1991), where they usually occupy littoral areas close to the shore (Mason 1974, as cited in Sandercock 1991). Movement of juvenile coho salmon into lakes in the fall for overwintering has been documented in the Tenmile Lakes, Oregon, and juvenile coho that rear in lakes have been found to grow faster and to outmigrate at larger sizes than juveniles rearing in streams. Rearing conditions are likely different in Soda Springs Reservoir than in the Tenmile Lakes, however, since Soda Springs Reservoir is colder, deeper, more oligotrophic, and has steeper banks than water bodies found in the Tenmile Lakes system.

If coho salmon spawn upstream of Soda Springs Dam, their progeny may be vulnerable to predation by brown and/or rainbow trout in Soda Springs Reservoir during fry or juvenile rearing and outmigration. Investigations conducted in support of the SA indicated that predation by resident trout on juvenile anadromous salmonids rearing or migrating through Soda Springs Reservoir could be substantial (Stillwater Sciences 2000) [“*Potential predation on juvenile anadromous salmonids in Soda Springs Reservoir under a fish passage scenario*”]. Results from the preliminary analysis were imprecise, but indicated that the survival of smolts from salmonids produced upstream of Soda Springs Reservoir could range from 0% to 57% depending on physical, biological, and environmental factors.

Under the proposed action, a long-term monitoring and predator control fund would be used to (1) monitor predation on juvenile anadromous salmonid by resident trout in Soda Springs Reservoir, and (2) control resident trout populations if monitoring indicates that predation is substantial, as determined by the Parties to the SA (Resource Conservation Committee). If predator control is determined to be needed, the pre-anadromous-fish-passage predator control program will be tested from 2006 through 2008.

Project operations that result in water surface level fluctuations in Soda Springs Reservoir may also result in stranding of fry or juvenile coho salmon in the reservoir. Such stranding is most likely to occur in the upstream portions of the reservoir. The effects of proposed ramping rates on stranding are discussed in Section 4.1.4.

Under the proposed action, downstream bypass facilities would be provided at Soda Springs Dam by the seventh anniversary of the new license. Juvenile coho salmon produced upstream of Soda Springs Dam as a result of providing fish passage, will need to pass downstream through Soda Springs Reservoir and past Soda Springs Dam to reach the ocean. Outmigrating juvenile salmonids (and any outmigrating adult steelhead [“kelts”]) would have three potential routes for downstream movement under the proposed action: (1) the downstream bypass facility, (2) the Soda Springs Dam spillway, or (3) the fish ladder.

The downstream bypass facility at the Soda Springs diversion is expected to reduce adverse Project impacts to listed salmonids by providing a safe passage route. This facility would be designed in consultation with NOAA Fisheries, FWS, ODFW, and FS to meet the performance standards outlined in Appendix B, Part 1, Table 1 of the SA.

Appendix B of the SA sets forth injury and mortality rates for the downstream bypass facility. Injury and mortality rates are summarized below in Table 7.

Table 7. Performance Standards for Soda Springs Dam Fish Screens.

Smolts > 60 mm in Length		Fry < 60 mm in Length	
Mortality	Injury	Mortality	Injury
Design performance objective < 0.5% mortality	Design performance objective < 2% injury	Design performance objective < 2% mortality	Design performance objective < 4% injury
Actual mortality > 0.5% but < 2% would require additional work to lessen mortality	Actual injuries > 2% but < 4% would require additional work to lessen injuries	Actual mortality > 2% but < 4% would require additional work to lessen mortality	Actual injuries > 4% but < 6% would require additional work to lessen injuries
Actual mortality > 2% would require major operational or structural changes	Actual injuries> 4% would require major operational or structural changes	Actual mortality > 4% would require major operational or structural changes	Actual injuries > 6% would require major operational or structural changes

Injury and mortality rates established for the proposed action will ensure that take of listed coho salmon will be minimized to the extent feasible, as some amount of injury and mortality is unavoidable. Given the present status and trends of coho salmon populations in the Umpqua River, NOAA Fisheries believes that the potential take of coho salmon juveniles as defined in Table 7 will not result in adverse impacts to the coho salmon population as a whole. Spawning and juvenile production permitted by construction of a fish ladder at Soda Springs Dam will likely offset the impacts of such take. Further, the process associated with screen planning and design was developed to ensure that such designs achieve or are less than these criteria. Through the planning process, NOAA Fisheries will review environmental and design criteria, and ensure that the above referenced standards are attained.

Some delay, injury, and mortality is expected to occur to smolts passing Soda Springs Dam via the spillway and adult fish ladder. However, the Soda Springs Dam spillway will likewise be modified after consulting with the agencies to improve downstream passage conditions for a range of spill magnitudes by providing depths and velocities sufficient for providing safe passage for juvenile and adult fish. The fish ladder will also be designed to accommodate downstream migrating salmonids. Measures that would be implemented under the proposed action are expected to ensure compliance with state and Federal fish passage criteria to reduce potential for injury, mortality, or delay.

The Fish Creek facility is the only project facility with a forebay downstream of Toketee Falls and having potential for access by anadromous salmonids. Fish Creek forebay would only be accessible to anadromous salmonids able to pass the potential natural barrier at RM 3.2 on Fish Creek. Under the proposed action, Fish Creek facility would be shut down during warm summer periods to reduce effects of the diversion on water temperatures in the Fish Creek bypass reach. The forebay would therefore be unavailable for year-round rearing by any anadromous fish produced from reaches upstream. Under the proposed action, any fish remaining in the waterways or canals prior to dewatering would be salvaged and returned to appropriate habitat. Under the proposed action, the Fish Creek diversion intake would be screened to reduce fish entrainment into the diversion canal and forebay. If juvenile coho salmon are produced by fish spawning upstream of this facility, some injury or mortality may result from impingement on screens, although the extent to which this may occurr is uncertain.

In summary, juvenile coho salmon that rear above Soda Springs Dam and subsequently migrate downstream under the proposed action may be affected by:

- Migration delays at Soda Springs Reservoir and Dam during downstream movement or outmigration;
- predation caused by creation of Soda Springs Reservoir, which provides habitat suitable to predators;
- injury or mortality associated with downstream passage at Soda Springs Dam through the bypass, spillway, or adult fish ladder;
- stranding resulting from flow fluctuations in Soda Springs Reservoir;
- warm water temperatures during fry and juvenile rearing in Fish Creek, which may reduce growth; or
- warm water temperatures during smolt outmigration in May and June in the Fish Creek, Slide Creek, and Soda Springs bypass reaches, which may result in sublethal effects such as shortened duration of smoltification, onset of desmoltification, and increased vulnerability to disease and infections (Wedemeyer et al. 1980).

The proposed action contains the following measures to minimize potential impacts associated with juvenile rearing and fish passage at Soda Springs Dam:

- Fish screens at the Soda Springs downstream juvenile bypass will be constructed to reduce delay and injury or mortality of juvenile coho salmon;
- Soda Springs spillway will be modified to reduce delay and injury or mortality of juvenile coho salmon;
- Soda Springs adult fish ladder will be designed to reduce potential for injury of juvenile coho salmon; and
- predation study and implementation of predator control plan if high predation rates are found should reduce mortality caused by presence of Soda Springs Reservoir.

Anticipated effects of passage at Soda Springs on coho salmon production in the North Umpqua River basin

Providing fish passage at Soda Springs Dam will likely have a relatively minor effects on coho salmon production and population abundance in the basin. The proposed action will result in anadromous fish, including coho salmon, regaining access to 6.6 miles of potential spawning and rearing habitat upstream of Soda Springs Dam. Upstream of Soda Springs Dam, the mainstem North Umpqua River is confined in a steep bedrock canyon and includes the following project features and reaches: (1) Soda Springs Reservoir (1.9 km [1.2 mi]), (2) Slide Creek full-flow reach (from Slide Creek powerhouse downstream to Soda Springs Reservoir, 0.3 km [0.2 mi]), and (3) Slide Creek bypass reach (3.2 km [2 mi]). An additional 5.1 km (3.2 mi) of habitat in Fish Creek will become accessible to coho salmon.

Although the majority of coho salmon currently spawn and rear in lower-elevation areas of the basin, some coho salmon spawn in the upper mainstem North Umpqua River (upstream of Steamboat Creek); therefore, a relatively small portion of the coho salmon population may use fish passage facilities at Soda Springs Dam. Suitable spawning and rearing habitat for coho salmon is limited upstream of Soda Springs Dam due to high channel confinement, coarse substrates, and lack of spawning gravels and LWD cover. Potential spawning habitat exists in the uppermost portion of Soda Springs Reservoir where suitably sized gravels have deposited. Coho salmon redds constructed in this area may be affected by water level fluctuations in the reservoir, which may result in egg and alevin mortality from poor hydraulics (intergravel flow), redd dewatering, or stranding of fry. Fry and juvenile coho salmon rearing in Fish Creek will be exposed to temperatures above the 17.8°C standard in July and August (18.8°C and 19.3°C, respectively), which is likely to result in reduced growth. Coho salmon smolts migrating through the Fish Creek, Slide Creek, and Soda Springs bypass reaches will also be exposed to warm water temperatures in June that may result in sublethal effects, such as shortened duration of smoltification, onset of desmoltification, and increased incidence of infection and disease (Wedemeyer et al. 1980). Fry and juvenile coho salmon rearing in the Slide Creek full-flow reach may be vulnerable to some stranding mortality due to flow fluctuations by the Project. Coho salmon rearing or migrating through Soda Springs Reservoir may be preyed on by resident trout within the reservoir, and by large resident brown trout and juvenile steelhead in the mainstem North Umpqua River downstream of Soda Springs Dam. Predator control measures are contained in the proposed action if predation in the reservoir is determined to be a significant problem by the Resource Coordination Committee. Some injury and mortality of coho salmon smolts is expected to occur at the bypass facility and for smolts passing Soda Springs Dam via the spillway and adult fish ladder, but mortality during downstream passage is expected to be low and will be addressed by measures contained in the proposed action. Fish screens at the bypass facility are expected to reduce injury or mortality during downstream passage of adult and juvenile coho salmon, and modifying the Soda Springs Dam spillway should reduce injury or mortality associated with downstream passage of adult and juvenile coho salmon passing over the spillway. Overall, constructing fish passage facilities at Soda Springs Dam may slightly increase coho salmon production in the watershed as a whole, but is not expected to result in either large benefits to or impacts on coho salmon in the North Umpqua River.

4.1.2.2 Upgrading the Rock Creek Hatchery Diversion Dam to Improve Upstream Fish Passage

The Rock Creek Hatchery Diversion Dam is a substantial obstacle to the upstream migration of anadromous salmonids under particular flow conditions, especially at lower flows. Based on radiotelemetry studies and observations at the Rock Creek Hatchery diversion facility, the dam and fish ladder currently prevent all upstream passage of juvenile salmonids, and prevent adult upstream passage by 10-30% of spring Chinook salmon, 30-50% of summer steelhead, 10% of winter steelhead, and 30-50% of coho salmon (D. Loomis, ODFW, pers. comm., 2001).

The Rock Creek Diversion Dam is not part of the North Umpqua Hydroelectric Project, but it represents a particularly important opportunity to increase access to anadromous salmonid habitat in the basin. Under the proposed action, PacifiCorp should provide 50% of the funding for upgrading the Rock Creek Hatchery Diversion Dam as mitigation for waiving fish passage at the Slide Creek Dam. Modifications to fish passage at Rock Creek Hatchery Diversion Dam are expected to substantially improve anadromous fish access to at least 62.5 km (39 mi) of spawning and rearing habitat upstream of the diversion. The design goal is to achieve 100% upstream and downstream passage for both juvenile and adult fish. The upgrade of the Rock Creek fishway will include a fish sorting facility to monitor adult fish escapement and reduce the potential for interbreeding and competition between hatchery and wild fish in the Rock Creek drainage. The hatchery currently has no facility for preventing the passage of hatchery fish into the Rock Creek basin above the dam; this may result in the mixing of hatchery and wild fish in natural spawning areas. Construction of this facility will benefit wild native anadromous salmonids by protecting their genetic integrity and reducing potential competition with progeny of hatchery fish, and will provide a means for monitoring population trends in the basin. Upgrading upstream fish passage conditions at the Rock Creek Hatchery diversion structure may afford the best opportunity for improving access to spawning and rearing habitat for coho salmon, migratory coastal cutthroat trout, steelhead, and Chinook salmon in the Action Area downstream of Soda Springs Dam. This measure, once implemented, should substantially increase spawning and rearing habitat availability for these species. Modifications to the Rock Creek Diversion Dam are expected to improve access for anadromous salmonids including 44.5 km (27.5 mi) of high-quality, low-gradient habitat for threatened coho salmon.

The amount of spawning and rearing habitat for which access would be improved under this measure has been estimated to be at least:

- 44.5 km (27.5 mi) for coho salmon,
- 62.5 km (39 mi) for steelhead, and
- 12.6 km (7.8 mi) for spring chinook salmon.

Under the proposed action, the Rock Creek Hatchery Diversion Dam would remain in place and may continue to cause migration delay of anadromous salmonids; however, the potential for upstream migration delay to occur at the diversion dam following the upgrading of fish passage facilities should be reduced by the measure.

Improving passage at the diversion dam could increase the number of hatchery fish spawning above the dam if they are not prevented from passing upstream, which could result in increased interbreeding between hatchery and wild coho salmon and steelhead. Construction of a sorting facility at the diversion dam would enable monitoring of adult fish populations and may be used to prevent passage of hatchery fish to natural spawning areas upstream. Preventing hatchery fish from accessing the Rock Creek watershed upstream of the diversion structure could benefit remaining wild anadromous salmonid stocks, particularly threatened OC coho salmon, through (1) reducing competition between wild and hatchery fish on the spawning grounds, (2) reducing interbreeding between hatchery and wild stock on the spawning grounds, and (3) reducing competition between progeny of naturally reproducing wild and hatchery fish in rearing areas. Anadromous salmonid habitat upstream of the diversion dam may be limited by warm summer water temperatures in the mainstem of Rock Creek (BLM 1996). Coho salmon, however, have been observed to use the lower reaches of cold-water tributaries to Rock Creek (Stillwater Sciences, unpubl. data).

Improving fish passage at Rock Creek Hatchery Diversion Dam should substantially benefit andromous salmonid populations in the basin by improving access to a substantial amount of habitat that may be currently underutilized because of passage conditions at the facility. The proposed action should increase accessibility of spawning and rearing habitat for coho salmon, steelhead, and spring chinook salmon populations in the basin.

4.1.2.3 Barriers Associated With the Project that Would Continue to Exist Under the Proposed Action

Under the proposed action, Slide Creek Dam would form the upstream-most barrier to upstream migration after the construction of fish passage facilities at Soda Springs Dam. Slide Creek Dam would continue to prevent access to 2.3 km (1.4 mi) of historically accessible anadromous fish habitat under the proposed action. This portion of the North Umpqua River includes the Toketee full-flow reach between the Toketee powerhouse and Slide Creek Dam (0.3 km [0.2 mi]), and the portion of the Toketee bypass reach downstream of Toketee Falls (1.9 km [1.2 mi]). Slide Creek Dam does not impound a reservoir; the reach upstream of this dam is effectively a pool-like portion of the full-flow reach downstream of Toketee powerhouse. The reaches upstream of Slide Creek Dam contain high-quality adult holding and juvenile rearing habitat; however, spawning gravels in these reaches are scarce, particularly in the Toketee bypass reach.

Although this area was historically accessible to coho salmon, their use of habitat upstream of Fish Creek has not been documented. It is therefore unclear that Slide Creek Dam actually represents a barrier to coho salmon. Because this habitat is at the extreme edge, and possibly outside of, the historical range of Umpqua River coho salmon spawning and rearing, the continued lack of passage at Slide Creek Dam is expected to have a negligible impact on the coho salmon population in the North Umpqua River.

4.1.3 Effects of the Proposed Action on Habitat Elements and Channel Conditions/Dynamics

Overview

The North Umpqua Hydroelectric Project affects the transport of sediment and LWD through the Action Area and thus has the potential to alter channel conditions downstream of project features. The majority of the watershed upstream of Soda Springs Dam is in the High Cascades/Surficial Deposits terrain, which is generally more resistant to weathering and supplies less sediment than Western Cascades geomorphic terrain found downstream of Soda Springs Dam. Because of this, sediment loading in the basin upstream of Soda Springs Dam is naturally low relative to areas downstream. Sediment supply to reaches downstream of the Project has increased due to land use, particularly from increased mass wasting associated with roads, logging, and waterway failures associated with the Project; in terms of the overall sediment budget in the Action Area, this increase partially compensates for sediment capture at Soda Springs Dam. Sediment contribution increases downstream of the dam as tributary basins contribute sediment. Downstream of the confluence with Steamboat Creek, sediment flux exceeds background conditions. The largest geomorphic impact is therefore in the reaches just below Soda Springs Dam (i.e., before downstream reaches supplement gravel inputs). The two reaches are differentiated by having reached bedrock or representing just 5% of reference materials (Stillwater Sciences 2000), respectively.

In addition, the naturally steep gradient and confinement of the North Umpqua River result in high sediment transport capacity. Because of this, the mainstem is characterized by a coarse bed with few areas where smaller sediments such as gravels can deposit. Overall, Project dams appear to have localized effects on substrate characteristics and sediment storage, but little effect on channel morphology within the Action Area.

Similarly, the high capacity of the mainstem to transport LWD makes its capture by Project features not likely to have a substantial effect on reaches downstream of the Project; however, the Project may continue to decrease the amount of wood transported to the Wild and Scenic River Reach if LWD becomes waterlogged upstream of or in the reservoir and is not able to be passed over the dam.

Attenuation of high flows by hydroelectric projects also has the potential to affect downstream channel morphology by reducing the frequency or magnitude of sediment transport. Larger magnitude high-flow events in the Action Area are relatively unchanged by the Project; therefore, channel processes and conditions that are influenced by high flow events are relatively unaffected by the Project.

Reservoirs impounded by project features alter channel morphology by transforming riverine reaches into lentic environments. Soda Springs Reservoir provides habitat for resident trout that could prey on fry or juvenile salmonids that must travel through the reservoir during outmigration.

Effects of the proposed actions on geomorphic processes and channel morphology
Measures included in the SA to address restoration of fluvial geomorphic processes include:

- Continued spawning gravel augmentation below Soda Springs Dam,
- gravel augmentation in Soda Springs alluvial restoration reach,
- passage of LWD over Project dams,
- passage of sediment past Slide Creek Dam,
- reconnection of the Clearwater River to the mainstem North Umpqua River,
- reconnection of numerous tributaries and drainages along the canal and flume systems, and
- replacement and upgrading of culverts to accommodate 100-year flood events.

These measures will provide greater connectivity of fluvial geomorphic processes in the Project area by allowing sediment and wood to be transported from tributaries in the upper North Umpqua River watershed, and much of it then transported past the Slide and Soda Springs dams into the Wild and Scenic River Reach and downstream. Restoration and enhancement of sediment dynamics and wood contribute to the formation of habitat for fish and other aquatic species.

The watershed analysis examined the effects of the Project, forest management activities, and other land uses on fluvial geomorphic processes, channel morphology, and aquatic and riparian habitats in the North Umpqua River basin. A summary of these analyses is presented in Section 2 of the Synthesis Report ("Fluvial geomorphic processes, channel morphology, and aquatic and riparian habitats") (Stillwater Sciences 1998).

Numerous studies conducted during the watershed analysis and subsequent investigations provided the technical basis for determining the effects of the Project and the expected effectiveness of the measures contained in the SA. Investigations conducted as part of the sediment budget analysis indicates that Project impoundments trap nearly all bedload transported from upstream reaches. Bedload delivery to the Slide Creek bypass and full-flow reaches has been reduced, although the effects are less evident downstream of the confluence with Fish Creek. In addition, bedload delivery to the Soda Springs Bypass Reach and the reach from Soda Springs Powerhouse to Boulder Creek have been reduced. The magnitude of bedload supply reductions downstream of Soda Springs Dam decreases in a downstream direction between Boulder Creek and Steamboat Creek, due to increased sediment production associated with roads and timber harvest in tributary basins.

Geomorphic investigations indicate little evidence of substantial change in channel morphology due to Soda Springs Dam downstream of Boulder Creek. Upstream of Boulder Creek, however, the changes were evident as a result of reduction of bed load supply from the upper basin. Similarly, the effects of Soda Springs Dam on downstream aquatic habitat are limited to the reaches just below the dam, and there is little evidence of channel change downstream.
Soda Springs Reservoir will continue to inundate 1.2 miles of historically accessible spawning and rearing habitat for anadromous salmonids. This reach appears to have contained a range of habitats under pre-project conditions, including low-gradient areas with alluvial features that are uncommon in the mainstem North Umpqua River. Prominent alluvial features and associated spawning habitat appear to have been present, though most of the reach likely consisted of riffle, run, and glide habitat with cobble-boulder bed materials of the type used to some extent by juvenile salmon. Under the proposed action, Soda Springs Reservoir may provide rearing habitat for juvenile coho salmon produced upstream of the reservoir. Riverine habitat that may have provided rearing habitat for coho salmon before construction of the Project will continue to be inundated.

Effects of the proposed action on substrate

Section 3.4.4 describes how features associated with the Project affect sediment transport throughout the Action Area. In general, project impoundments that capture bedload can influence substrate conditions downstream. The mainstem North Umpqua River downstream of Toketee Falls has a high transport capacity that could result in bed coarsening and/or bar reduction from reduced bedload. Preliminary investigations do not suggest a definitive trend in grainsize with distance downstream from the dam, and suggest that grainsize D50 may be determined by local rather than watershed-scale conditions. Grainsize D50 also appears to be coarser between Soda Springs Dam and Boulder Creek than in the rest of the basin. This is a relatively steep reach with high stream power and a substantial reduction of bedload due to capture at project dams. Soda Springs Dam will continue to capture bedload from reaches upstream and may continue to effect substrate conditions in this reach. The status of the substrate PFC indicator was determined to be at risk under environmental baseline conditions and the proposed action will not change this status.

Measures to be implemented under the Proposed Action are expected to improve habitat conditions for anadromous salmonids by enhancing spawning habitat conditions and reducing fine sediment inputs. Improving sediment transport between Clearwater River to North Umpqua River may increase supply of spawning gravel to mainstem reaches accessible to anadromous salmonids. Continuing to augment spawning gravels below Soda Springs Dam and passing sediment past Slide Creek Dam will provide an ongoing source of spawning gravel to reaches where sediment supply is limited. Spawning habitat enhancements proposed in the North Umpqua River and Slide Creek bypass reaches should increase storage of spawning gravels for anadromous salmonids. In addition, increasing LWD loading in East Fork Rock Creek may improve retention and sorting of spawning gravels used by anadromous salmonids.

Reducing erosion along Project waterways is expected to reduce fine sediment inputs to the stream network and maintain quality of spawning gravels and rearing substrate in downstream reaches accessible to anadromous salmonids. Erosion control measures will reduce the potential for waterway failures to impact spawning and rearing habitat in reaches accessible to anadromous fish.

Decommissioning roads and upgrading culverts is also expected to reduce fine sediment inputs related to erosion and maintain quality of spawning gravels and rearing substrate in downstream reaches accessible to anadromous salmonids.

Effects of the proposed action on large woody debris

The status of the LWD PFC indicator was determined to be not properly functioning under current environmental baseline conditions, largely because of past logging and stream clearance; the status of the indicator will not change under the proposed action. The Project does affect the transport of LWD through the project-affected reaches; however, much of the mainstem North Umpqua River has a high transport capacity for LWD and LWD may not have been abundant in these reaches under historical conditions. LWD will continue to be passed over Project dams under the proposed action, but this measure does not likely substantially increase LWD in project-affected reaches. Highway 138 has likely played a more significant role than project dams in reducing LWD delivery to the mainstem, by intercepting logs that were once delivered to the channel.

LWD enhancements in East Fork Rock Creek will increase the number of key LWD pieces in the East Fork Rock Creek basin and increase habitat quality and quantity for rearing anadromous salmonids. Under current conditions, East Fork Rock Creek is a low-gradient stream channel that lacks habitat complexity due to past management activities in the basin. Because restoration of natural LWD recruitment mechanisms would likely require at least 50 to 60 years following cessation of logging (Grette 1985; Andrus et al. 1988), active placement of LWD in East Fork Rock Creek is expected to be a valuable short-term measure to improve stream habitat conditions, but will not bring the LWD PFC indicator to properly functioning conditions in the enhancement area.

Because of the low-gradient, unconfined channel habitat available in East Fork Rock Creek, LWD enhancement efforts may have a relatively high potential for increasing production of coho salmon, steelhead, coastal cutthroat trout, and Pacific lamprey (spring chinook salmon are not currently found in this reach). The objective of LWD enhancements in East Fork Rock Creek is to increase instream habitat complexity, and thereby increase the winter carrying capacity for coho salmon and other salmonids. LWD enhancement in the Rock Creek basin would result in both direct and indirect benefits for anadromous fish. Increased LWD in stream channels should enhance the structural complexity of in-channel habitats and increase the amount and quality (e.g., increased depth and cover) of LWD-associated pool habitat available for salmonids. Such pools provide velocity refuge from high flow events and may provide temperature refugia during periods of low flow. In unconfined reaches, increased LWD may increase the amount of side-channel and off-channel habitat available for rearing salmonids and lamprey ammocoetes. Increased complexity of channel margin habitat and improved bank stability should improve early fry rearing habitat for anadromous salmonids. Increases in in-channel LWD should also increase sorting and retention of gravel-sized sediment, with potential benefits for species that spawn in the affected tributaries. Retention of fine and coarse organic material and salmonid carcasses may improve nutrient cycling and food supplies for rearing salmonids as well.

Overall, project features will continue to affect sediment and LWD transport in the Action Area and have localized effects on channel conditions downstream. Measures included in the Proposed Action will minimize the effects of the Project on habitat elements and channel conditions in the Project area. Localized effects on substrate characteristics and in-channel LWD loading continue under the proposed action, and dams will continue to inundate sections of the river channel.

Effects of the proposed on pool frequency and quality

The status of the pool frequency PFC indicator was determined to be not properly functioning under environmental baseline conditions; however, there is no evidence that the Project has substantially affected pool frequency in the Action Area. The status of the pool quality PFC indicator was determined to be properly functioning under baseline conditions. The proposed action will not change the status of these indicators. LWD enhancement in East Fork Rock Creek is intended to increase the increase pool frequency in the East Fork Rock Creek basin and increase habitat quality and quantity for rearing anadromous salmonids.

Effects of the proposed action on off-channel habitat

The status of the off-channel habitat PFC indicator was determined to be at risk under the environmental baseline. Off-channel habitat is naturally uncommon in the mainstem North Umpqua River and Fish Creek due to their confined valleys. There is no evidence that the Project has led to substantial reductions in off-channel habitat in the Action Area; therefore, the proposed action will not change the status of this indicator. LWD enhancement in East Fork

Rock Creek is expected to increase off-channel habitat in the East Fork Rock Creek basin and increase habitat quality and quantity for rearing anadromous salmonids. Off-channel habitat would not likely be affected in the mainstem North Umpqua River and reaches expected to become accessible to anadromous fish under implementation of the SA.

Effects of the proposed action in width/depth ratio
The status of the width/depth ratio PFC indicator was determined to be unknown for the environmental baseline; the proposed action is not expected to change width/depth ratios in the Action Area. Channel morphology in much of the North Umpqua River basin is bedrock-controlled and is therefore less likely to change as a result of anthropogenic disturbances. Riparian conservation easements, however, could further protect channels from management-related changes in channel morphology in the Rock Creek basin.

Effects of the proposed action on streambank condition
Streambanks in Project-affected reaches (bypass reaches and full-flow reaches of the North Umpqua River, Clearwater River, and Fish Creek) are considered to be very stable. The status of the streambank condition PFC indicator was therefore determined to be properly functioning under environmental baseline conditions and the proposed action is not anticipated to change these conditions.

Effects of the proposed action on floodplain connectivity
The status of the floodplain connectivity PFC indicator was determined to be at risk in the Action Area; however, floodplain habitats associated with unconfined channels are naturally uncommon in the mainstem North Umpqua River. Throughout most of the basin, streams are relatively confined and lacked extensive floodplains under pre-Project conditions. There is no evidence that the Project has substantially affected floodplain connectivity and the proposed action will not change the status of this indicator.

4.1.4 Effects of the Proposed Action on Flow/Hydrology

Overview
The proposed action will affect baseflows, high flows, and flow fluctuations in project-affected reaches accessible to anadromous salmonids. Minimum flows in bypass reaches accessible to anadromous salmonids were selected to provide substantial habitat based on WUA for coho and spring chinook salmon and steelhead adult and juvenile rearing. Low-magnitude, high-frequency high-flow events will be reduced by project operations in bypass reaches accessible to anadromous fish; however, higher magnitude high-flow events (>5-year recurrence interval) that are important for influencing channel morphology and bed characteristics will remain relatively unaffected by the Project due to its limited storage and diversion capacity.

Project operations included in the Proposed Action will result in frequent flow fluctuations (ramping) in full-flow reaches accessible to anadromous fish. Flow fluctuations in bypass reaches will only occur in association with unplanned emergency shutdowns or project maintenance. Upramping of flows by the Project may displace eggs, fry, or juvenile fish; increase turbidity, or alter water temperature and dissolved oxygen. Downramping may result in redd dewatering or stranding of fry or juvenile salmonids. Flow fluctuations will likely reduce macroinvertebrate production in the relatively short full-flow reaches through frequent dewatering of stream channel margins. Restrictions on ramping rates and the timing of project maintenance are included in the proposed action to reduce the potential for redd dewatering, stranding, and other potential adverse effects on salmonids and other aquatic species.

4.1.4.1 Effects of the Proposed Action on Instream Flows

Section 3.4.5 describes current minimum flows for reaches within the Action Area. Under the proposed action, the Project would continue to divert streamflows in order to produce hydroelectric power. Instream flows in bypass reaches influence habitat quantity and quality for anadromous salmonids. Instream flows in the Soda Springs bypass reach would increase from the current minimum of 25 cfs to 275 cfs under the proposed action. The resulting summer and winter flows would be about 31% and 27%, respectively, of the average undiverted baseflows. In the lower Slide Creek bypass reach, stream flows would increase from 25 cfs under existing conditions, to 240 cfs once anadromous fish passage facilities are constructed at Soda Springs Dam (year-7). Minimum flows in the interim would be 50 cfs during winter and 80 cfs during summer. Subsequent to providing fish passage, minimum flows (240 cfs) would be about 32% of average unregulated flows during summer and 26% during winter. In the Fish Creek bypass, instream flows would increase from 10 cfs in winter and 20 cfs in summer under existing conditions, to 130 cfs once anadromous fish passage facilities are constructed at Soda Springs Dam (year-7). Minimum flows in the interim would be 50 cfs during winter and 80 cfs during summer. Subsequent to anadromous fish passage, minimum flows (130 cfs) would provide at least 80% of average unregulated baseflows during winter. The project would be shut down during summer when baseflows fall below the minimum instream flow of 130 cfs. A summary of the results of the instream flow analysis are provided below to describe habitat changes that would resulting from the proposed action.

Implementation of minimum instream flow guidelines contained in the SA would result in increased flows and habitat availability in all bypass reaches that are currently accessible to anadromous fish, or that would become accessible as a result of providing fish passage at Soda Springs Dam. Subsequent to providing passage, minimum instream flows for the Slide Creek Bypass Reach would provide 75% of peak WUA for coho salmon. WUA for coho salmon was not modeled for Fish Creek. Minimum flows for the Soda Springs bypass reach will provide 94% to 99% of peak WUA for juvenile anadromous fish (steelhead, coho salmon, and chinook salmon) rearing, and 84% to 96% of peak WUA for spawning (steelhead, coho salmon, and chinook salmon) under both pre- and post-passage conditions. A comparison of the effects of minimum instream flows under the proposed action with unregulated baseflows is unavailable. Project operations will continue to affect flows and flow fluctuations in project-affected reaches. Measures included in the proposed action will provide flows suitable for spawning and rearing by coho salmon and other anadromous salmonids. These flows were selected to maximize WUA for the juvenile rearing life stage of these species.

4.1.4.2 Effects of the Proposed Action on High Flow Events

High flows can influence the behavior and survival of adult and juvenile anadromous salmonids. The timing of adult migration often occurs as high flows decrease, and migration typically ceases during the peak of high flows. Juveniles seek velocity refuge during winter high flows, and typically outmigrate during spring high flows. Low-magnitude high flows often provide feeding opportunities for juvenile salmonids, while peak flows can be a significant source of mortality.

High flows influence the geomorphology and ecology of streams by transporting and depositing fine and coarse sediment and LWD, controlling riparian encroachment and channel narrowing, and maintaining connectivity between channels and floodplains.

The status of the change in peak/base flows PFC indicator was determined to be not properly functioning under environmental baseline conditions because of flow regulation by the Project. High flows will remain relatively unchanged compared with current conditions. Compared to undiverted conditions, high flows are generally reduced by the capacity of each project diversion. The capacity of the Fish Creek, Slide Creek, and Soda Springs diversions are 4.3 cms (150 cfs), 42.6 cms (1,500 cfs), and 45.3 cms (1,600 cfs), respectively. High-frequency high flows will continue, therefore, to be reduced while high flows of greater than 5-year recurrence interval will remain less affected.

Soda Springs Dam does not affect the hydrology of the basin downstream of the Soda Springs powerhouse, and therefore does not influence hydrologic events able to transport sediment. However, the hydrology has been severely altered in the diversion reach between the dam and the powerhouse. High-frequency flows have been substantially reduced, but low-frequency flows are essentially unaltered relative to reference conditions. This means that flows capable of transporting sediment still occur and result in bed coarsening, or even scour to bedrock. Channel conditions are not expected to be adversely affected by project attenuation of lower-magnitude high flows because of the confinement and coarse substrate of the channel in this portion of the river. Flow regulation will reduce seasonal flow changes that anadromous salmonids may use as behavioral cues during spawning and outmigration or other life stages.

4.1.4.3 Effects of the Proposed Action on Flow Fluctuations/Ramping Rates

Flow fluctuations occur in project full-flow reaches and bypass reaches. The greatest water surface level fluctuations occur in full-flow reaches where releases from project facilities change depending on generation schedules. Bypass reaches generally maintain relatively stable minimum flows with very little water surface level fluctuations.

Under the proposed action, ramping rates will be restricted in certain project-affected reaches. No ramping will occurr in the Wild and Scenic River reach at flows below 1,600 cfs. At flows above 1,600 cfs, ramping in the Wild and Scenic River reach will be limited to 0.1 ft/hour. This is lower than the 0.5 ft/hour downramping rates which occurred naturally under reference conditions (Synthesis Report, p. 4-16) and should reduce the potential for stranding of salmonids.

Under the proposed action, ramping rates will be 0.2 ft/hr in the Soda Springs bypass reach, and 0.5 ft/hr in all other project bypass reaches. There will be no ramping restrictions in the Slide Creek full-flow reach until parties to the SA agree to such restrictions following studies to assess the impacts of ramping in this reach. The monitoring plan to assess the potential effects of ramping shall be approved by the agencies by the sixth anniversary of the new licence or by 2010, whichever is earlier. There will be no ramping restrictions in the Toketee full-flow reach, which will remain upstream of the distribution of anadromous fish under the proposed action.

Flow fluctuations can result in stranding or entrapment of juvenile and adult salmon in dewatered or isolated areas as flows recede (during downramping). Stranding occurs when fish are trapped in dewatered areas and die of asphyxiation or desiccation. Entrapment occurs when fish are isolated in potholes or side channels that become separated from the flowing channel. These entrapped fish may subsequently become stranded if flows continue to recede. They may also be subject to increased predation and physiological stress (caused by high temperatures and oxygen deficit). Stranding and entrapment of juvenile salmonids were documented in the mainstem North Umpqua River upstream of the mouth of Rock Creek in the Wild and Scenic River reach in June 2000. Such events are not expected to occur under the Proposed Action, except during unplanned emergency shutdowns, which may cause stranding on rare occasions. Flow fluctuations may affect food resources for salmonids by eliminating or reducing macroinvertebrate habitat and production. Flow fluctuations during spawning seasons can also result in dewatering of redds, and fluctuations can also reduce stream-margin rearing habitat for juveniles. The proposed action will reduce the potential for stranding, entrapment, reduced macroinvertebrate production, redd dewatering, and loss of stream-margin habitat through restrictions on ramping rates.

Measures included in the Proposed Action will reduce potential stranding of anadromous salmonids, compared to current Project effects, through restrictions on ramping rates and timing of fluctuations associated with project maintenance. Some stranding of fry and juvenile salmonids may occur in the Slide Creek full-flow reach under the proposed action; however, little potential stranding habitat is present in this reach due to the high degree of channel confinement and lack of bars or other channel features that would be exposed during fluctuations. This reach is also relatively short (0.2 mi) and not much spawning or rearing is expected to occur in this reach because of its confined channel and lack of spawning gravels. Macroinvertebrate production may also be reduced by dewatering of channel margins (Cushman 1985). Downstream of Soda Springs powerhouse, ramping rates will be restricted to avoid adverse effects in the Wild and Scenic River Reach (Section 2.3.1.1).

4.1.5 Effects of the Proposed Action on Riparian Reserves

The Late Successional Reserve in the Rock Creek basin is fragmented; nearly all of the LSR occurs as isolated sections of Federal lands in a checkerboard pattern completely surrounded by private land. This fragmentation reduces the overall benefit to Federal lands basin with LSR designation in the and the large investment inherent in this designation.

The mainstem of Rock Creek contains relatively long low-gradient, alluvial reaches that are uncommon in the Action Area downstream of natural and artificial barriers to anadromous salmonids. Under current conditions, high stream temperatures in the summer and fall low-flow periods likely stress or exclude juvenile coho salmon, steelhead, and cutthroat trout rearing in the mainstem Rock Creek during these periods. High stream temperatures in the summer and fall low-flow periods may also be stressful to spring chinook salmon during adult holding, spawning, and incubation and may be a factor limiting spring Chinook salmon production in the basin.

Under the proposed action, riparian conservation easements would be implemented in the Rock Creek basin to increase riparian protection in the long term through purchase of conservation easements on private timberlands to protect these areas in perpetuity. Riparian conservation easements would be designed to increase stream channel shading and reduce temperatures in mainstem Rock Creek and certain tributaries. Easement purchases would be based on compensation to private landowners for habitat protection measures that would not already be required under state and Federal regulations. PacifiCorp should conduct effectiveness monitoring of riparian buffers in the Rock Creek basin. Studies of the influence of riparian buffers on stream channels would consist of monitoring stream temperatures prior to and subsequent to protection of riparian buffers, as well as long-term LWD surveys to monitor the recruitment of LWD to reaches adjacent to these buffers. PacifiCorp should monitor the conservation easements to ensure that landowners are managing the land in strict accordance with the terms of the easement.

The proposed action, in combination with management guidelines included in the NFP and overall enhancement efforts in the Rock Creek basin, should function to increase protection for riparian and aquatic habitats in the basin, resulting in improved habitat conditions for anadromous and resident fish. In the long term, benefits related to the enhancement or restoration of riparian functions would be expected to include recruitment of LWD to stream channels and riparian areas, input of fine and coarse organic matter important for nutrient cycling, and shading of stream channels (fine sediment input is not currently believed to be a problem in the Rock Creek basin). Old-growth and riparian-associated wildlife species, including the Northern spotted owl, would be expected to benefit in the long term from protection of riparian forest stands as nesting and foraging habitat and movement corridors, and the recovery of late-seral characteristics, such as increased downed wood, snags, and large trees in riparian areas. Acquisition of riparian conservation easements along unconfined, low-gradient, alluvial reaches of Rock Creek could maintain and restore ecological functions of relatively rare floodplain habitat that provides excellent overwintering habitat for anadromous salmonids, particularly coho salmon. Areas that may be considered for riparian conservation easements under this measure are shown in the Potential Buffers, Corridors, and Other Enhancements Map.

The mainstem North Umpqua River currently provides high-quality spawning and rearing habitat for spring Chinook salmon and steelhead. Coho salmon and migratory coastal cutthroat trout are far more dependent on tributaries for spawning and rearing, many of which are in degraded condition from past logging in riparian areas, valley bottom road construction, and LWD removal. Many tributary watersheds in the North Umpqua River basin are currently a patchwork of Federal and private ownership. Although riparian stands located within Federally owned lands will receive protection under NFP guidelines to protect aquatic resources, riparian areas on privately owned timberlands will be subject to less stringent forest practice rules (e.g., narrower buffer widths). Future logging and road construction on private lands within the Rock Creek basin may further reduce stream channel shading and LWD recruitment to stream channels that are already compromised as salmonid habitat by warm stream temperatures and a lack of in-channel LWD (fine sediment does not appear to be a problem in Rock Creek).

The acquisition of riparian conservation easements in the Rock Creek basin would be designed to provide long-term protection from further riparian and stream habitat degradation by protecting essential riparian functions such as stream channel shading and LWD recruitment. Under current conditions, summer low-flow water temperatures may be above the range that is suitable for juvenile coho salmon and cutthroat trout rearing and may thus limit the amount of habitat available for these species. Stream temperature modeling (BasinTemp) would be used to select areas where protecting riparian areas would most benefit coho salmon and coastal cutthroat trout by reducing stream temperatures to within the range of suitability for juvenile rearing. In reaches where temperatures become suitable for rearing, further habitat enhancement efforts, such as LWD placement, could be employed to increase carrying capacity for rearing juvenile coho and cutthroat in these reaches. Increasing LWD recruitment to stream channels over the long term should also (1) increase sorting and storage of spawning gravels for these species, and (2) enhance storage of smaller woody debris, fine particulate organic matter, and anadromous salmonid carcasses, potentially increasing productivity of this stream for salmonids as well as other aquatic and terrestrial species (Section 4.2.1).

Providing riparian conservation easements in the Rock Creek basin to extend the benefits of protection on Federal lands is not likely to adversely affect fish anadromous salmonids able to utilize habitat in the Rock Creek basin. The proposed measure is not likely to adversely affect andromous salmonid populations in the North Umpqua basin or the Oregon Coast ESU.

4.1.6 Summary of All Effects of the Proposed Action

Table 8 shows how the PFC pathways and indicators are expected to be affected by the proposed action.

Table 8. Summary of effects of proposed action on Oregon Coast coho salmon. IMP = impair properly functioning habitat; RED = appreciably reduce the functioning of already impaired habitat; RET = retard the long-term progress of impaired habitat towards properly functioning condition; NR = not reduce, retard, or impair; NPF = baseline not properly functioning; AR = baseline at risk; PFC = baseline properly functioning.

Proposed Action Element	**Project Effects**	**Habitat Matrix Effects**		**Base-line**	**Effect of Action**	**Comment**
		Habitat	**Life Stage**			
Divert water from bypass reaches at rates that maintain minimum flows described in Section 2.3.2.1; monitor instream flows to maintain minimum flows per Section 2.3.2.2	Increase temperature during summer months	Water Quality - Temperature	Juvenile rearing and migration	AR	NR	Only a slight increase in temperatures above those which would occur without diversion. Because minimum flows are higher than in past, this is a reduction in adverse effects that contributed to status under baseline.
	Decrease temperature during winter months	Water Quality - Temperature	Adult spawning and incubation	AR	NR	Temperatures will be near lower lethal limit for short periods in Fish Creek and Slide Creek bypasses. However, few coho are likely to use this habitat. Because minimum flows are higher than in past, this is a reduction in adverse Project effects that contributed to status under environmental baseline.
	No effect	Water Quality - Chemical Contamina-tion & Nutrients	All	PF	NR	No Project-caused reduction in dissolved oxygen or increase in chemical contamination, etc.
	Reduce available spawning and rearing habitat	Flow/ Hydrology	Adult passage, holding, spawning; juvenile rearing and passage	NPF	NR	Minimum flows will provide at least 94% peak WUA for juveniles and 84% for adults in Soda Springs bypass. Somewhat lower levels upstream, but these areas less likely to be used by coho. Because minimum flows are higher than in past, this is a reduction in adverse Project effects that contributed to status under environmental baseline.

Manage flows in bypass reaches so that fluctua-tions do not exceed ramping rates described in Section 2.3.2.3; schedule mainten-ance for high flow periods	Flow fluctuations during maintenance and emergencies may strand juvenile coho salmon or dewater redds.	Flow/ Hydrology	Eggs, alevin, and juveniles	NPF	NR	Ramping will be eliminated except during emergencies and planned maintenance, which will occur infrequently and/or during period when natural flow fluctuations occur. Because flow fluctuations are greatly restricted compared to past operations, this is a reduction in adverse Project effects that contributed to status under environmental baseline.
	Flow fluctuations during planned maintenance and emergencies may increase turbidity	Water Quality - Turbidity	All, especially eggs and alevin	PFC	NR	Planned maintenance activities restricted to natural high-flow periods when turbidity pulses occur naturally. Ramping rate restrictions during emergencies will reduce magnitude of turbidity pulses. This represents a reduction in adverse Project effects that contributed to status under environmental baseline.

Operate Soda Springs Dam 2002 - 2009 with current configuration for seven years per Section 2.3.1.1; gravel augmentation, pass LWD, Soda Springs spawning habitat improvement 2002 through license period per Section 2.3.3	Blocks access to some historic anadromous salmonid habitat	Access - Barriers	All	NPF	NR	Access will continue to be blocked, but habitat above Soda Springs is currently and historically marginal for coho, so impact on N. Umpqua population is minor. No change from Project effects that contributed to status under environmental baseline.
	Blocks sediment and LWD passage to lower reaches	Habitat Elements - Substrate, LWD, pool frequency, etc.	All	PFC - NPF	NR	Habitat restoration and enhancement projects should mitigate for primary dam effects on downstream spawning and rearing habitat. This represents a reduction in adverse Project effects that contributed to status under environmental baseline.
Install adult fish ladder and juvenile screens and bypass facilities at Soda Springs Dam by 2009 per Section 2.3.1.1	Possible delay, injury, or mortality associated with passage	Access - Barriers	Adult, Juvenile	NPF	NR	Will allow access to marginal historical coho spawning and rearing habitat, which eliminates an adverse Project effect that influenced environmental baseline. A relatively small proportion of N. Umpqua population is expected to attempt to pass Soda Springs, so any delay or injury will have minor effect on population. Design standards and monitoring should ensure that delay is minor and injury rates are low.

	Possible turbidity, erosion, and contaminants related to construction activities	Water Quality - Turbidity, Chemical Contamina-tion	All	PFC	NR	NOAA Fisheries must approve construction plans to ensure that construction activities will minimize erosion and sediment input, control for pollution, and inwater work will be timed and implemented in a manner that minimizes harm to listed coho salmon.
		Habitat Elements - Substrate	All	NPF	NR	
Install tailrace barriers at Soda Springs power-house per Section 2.3.1.1	Possible attraction of adults to tailrace, delaying migration	Access - Barriers	Adult	NPF	NR	Tailrace barrier will alleviate this problem. This represents a reduction in adverse Project effects that contributed to status under environmental baseline.
	Possible turbidity, erosion, and contaminants related to construction activities	Water Quality - Turbidity, Chemical Contamina-tion	All	PFC	NR	NOAA Fisheries must approve construction plans to ensure that construction activities will minimize erosion and sediment input, control for pollution, and inwater work will be timed and implemented in a manner that minimizes harm to listed coho salmon.
		Habitat Elements - Substrate	All	NPF	NR	

Restrict flow fluctua-tions below Soda Springs Dam and install emerg-ency bypass valve to accom-plish this per Section 2.3.1.1	Flow fluctuations may strand juvenile coho salmon or dewater redds.	Flow/ Hydrology	Eggs, alevin, and juveniles	NPF	NR	Ramping will be reduced to 0.1 ft/hr and 6 inches per day. Because flow fluctuations are greatly restricted compared to past operations, this is a reduction in adverse Project effects that contributed to status under environmental baseline.
Maintain Soda Springs Reservoir and allow reservoir fluctua-tions of up to 16 ft/day per 2.3.1.1; predator studies and predator control program per Section 2.3.1.3	Historical spawning and rearing habitat inundated	Habitat Elements (e.g., pool frequency; off-channel habitat)	Eggs, alevin, and juveniles	PFC - NPF	IMP, RED	Continued presence of reservoir will reduce spawning and rearing habitat function. However, this is in historically marginal habitat and should have minor effect on N. Umpqua population.
	Reservoir fluctuations may strand juveniles	Flow/ Hydrology	Eggs, alevin, and juveniles	NPF	IMP	Large fluctuations may strand juveniles migrating through reservoir. However, this is in historically marginal habitat and few coho are likely to be affected. Should have minor effect on N. Umpqua population.
	Reservoir creates habitat for trout and other predators of juvenile coho	Habitat Elements (e.g., pool frequency; off-channel habitat)	Juveniles	PFC - NPF	IMP, RED	For any coho that spawn above Soda Springs, significant juvenile mortality through the reservoir is likely. Possible predator control program will have unknown ability to mitigate. However, this is in historically marginal habitat and few coho are likely to be affected. Should have minor effect on N. Umpqua population.

Operate Fish Creek Dam with current configura-tion per Section 2.3.1.2	No Effect	Access - Barriers	All	PFC	NR	Coho salmon were historically observed in lower reach of Fish Creek; however, dam is 3 miles above likely natural barrier to coho salmon.
Operate Slide Creek Dam with current configura-tion per Section 2.3.1.3; pass sediment and LWD and enhance spawning habitat in Slide Creek bypass reach per Section 2.3.3	No Effect	Access - Barriers	All	PFC	NR	Coho salmon were not historically observed upstream of lower reach of Fish Creek, so unlikely that Slide Creek Dam is barrier to coho. If it is a barrier, effects are minor as it is at extreme range of coho so very few fish would be affected. Also, potential habitat is restricted to 2.2-km reach downstream of Toketee Falls.
	Blocks sediment and LWD passage to lower reaches	Habitat Elements - Substrate, LWD, pool frequency, etc.	All	PFC - NPF	NR	Habitat restoration and enhancement projects should mitigate for primary dam effects on downstream spawning and rearing habitat. This represents a reduction in adverse Project effects that contributed to status under environmental baseline.
Operate other upriver projects per Section 2.3.1.4	No Effect	Access - Barriers	All	PFC	NR	All other sites are clearly above historical coho salmon spawning and rearing habitat. Any downstream effects are captured in descriptions of effects of downstream projects.

Establish general mitigation fund for US Forest Service and BLM land per Section 2.3.1.3	May reduce project impacts on riparian areas	Habitat Elements - substrate, pool frequency/ quality, off-channel habitat; Water Quality - sediment/ turbidity; Channel Conditions and Dynamics	All	PFC - NPF	NR	Projects may include stream or riparian enhancement and road decommissioning. Represents a reduction in adverse Project effects that contributed to status under environmental baseline.
Reconnect Clear-water River to the mainstem N. Umpqua River per Section 2.3.3	Reduce project impacts on sediment transport, LWD transport	Habitat Elements - substrate, LWD; Water Quality - sediment/ turbidity	All	PFC - NPF	NR	Will restore coarse sediment and LWD transport from Clearwater River to N. Umpqua River and may increase retention and sorting of spawning gravel in mainstem reaches accessible to coho salmon. Represents a reduction in adverse Project effects that contributed to status under environmental baseline.
Replace and upgrade culverts associated with Project-related roads to accommo-date 100-year flood events and per Section 2.3.3	Without proper-sized culverts, culverts and roads wash out, increasing fine sediments downstream	Water Quality - sediment/ turbidity	All, especially eggs and alevin	PFC	NR	Culvert replacement should reduce adverse effects of Project-related roads on downstream spawning and rearing habitat. This represents a reduction in adverse Project effects that contributed to status under environmental baseline.
	Possible turbidity, erosion, and contaminants related to culvert replacement	Water Quality - Turbidity, Chemical Contamina-tion	All	PFC	NR	NOAA Fisheries must approve construction plans to ensure that culverts are replaced in a manner that will minimize erosion and sediment input, control for pollution, and inwater work will be timed and implemented in a manner that minimizes harm to listed coho salmon.
		Habitat Elements - Substrate	All	NPF	NR	

Implement erosion and sediment control plan along Project waterways per Section 2.3.3	Canal and flume failures can increase turbidity and fine sediments	Water Quality - sediment/ turbidity	All, especially eggs and alevin	PFC	NR	Culvert replacement, installing drain pipes, and removing sidecasted soil should reduce adverse effects of Project-related waterways on downstream spawning and rearing habitat. This represents a reduction in adverse Project effects that contributed to status under environmental baseline.
	Possible turbidity, erosion, and contaminants related to culvert replacement and drain pipe installations	Water Quality - Turbidity, Chemical Contamination	All	PFC	NR	NOAA Fisheries must approve construction plans to ensure that culverts are replaced and drains installed in a manner that will minimize erosion and sediment input, control for pollution, and inwater work will be timed and implemented in a manner that minimizes harm to listed coho salmon.
		Habitat Elements - Substrate	All	NPF	NR	
Decommission unneeded Project roads per Section 2.3.3	Erosion associated with roads can increase turbidity and fine sediments. Roads can also impact drainage networks.	Water Quality - sediment/ turbidity; Flow/ Hydrology - drainage networks, road density	All, especially eggs and alevin	PFC	NR	Decommissioning unneeded Project roads should reduce adverse Project effects on downstream spawning and rearing habitat. This represents a reduction in adverse Project effects that contributed to status under environmental baseline.

4.2 Interrelated and Interdependent Effects of Proposed Action

Interrelated and interdependent effects of the proposed action are those effects that would not occur if the proposed action were not implemented and that are not directly addressed by measures incorporated into the proposed action. Depending on future decisions regarding fishing regulations on the North Umpqua River, sport fishing for salmon and steelhead may occur upstream of Soda Springs Dam following construction of fish passage facilities there. Increasing the spatial extent of sport fishing may result in increased hooking injury or mortality of juvenile and/or adult salmonids, and reduced number of adult spawners. Poaching of salmon or steelhead may also increase in reaches newly accessible to anadromous salmonids. Between 1984 and 1993, in-river sport fishing harvest rates on coho salmon at Winchester Dam ranged from 11-17% (PacifiCorp 1995). This is not expected to change under the proposed action.

5. CUMULATIVE EFFECTS

The ESA requires NOAA Fisheries to evaluate the cumulative effects of the proposed action on listed species and designated critical habitat and to consider cumulative effects in formulating biological opinions (50 CFR §402.14). The ESA defines cumulative effects as "those effects of future state or private actions, not involving Federal activities that are reasonably certain to occur within the actions area" of the proposed action subject to consultation (50 CFR §402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA. Federal actions, including hatcheries, fisheries, and land management activities are, therefore, not included. The biological opinion for the proposed action would expire when the new FERC license expires. The cumulative effects analysis, therefore, is limited to the period of the new license. The area of cumulative effects analysis is the Action Area, which was defined in Section 2.2 as the North Umpqua basin from its headwaters downstream to and including Rock Creek.

A number of other commercial and private activities, including timber harvest, recreation, and urban and rural development, that could potentially affect listed species occur in the North Umpqua basin, as discussed below. PacifiCorp is not aware of any additional state or private action in the Project area that is reasonably certain to occur or that would affect the listed species or their critical habitat. It is likely that ongoing non-Federal activities that affect listed salmonids and their habitat would continue in the short-term at similar intensities as in recent years.

5.1 Geology and Soils

Erosion, landsliding, and sediment deposition are strongly influenced by timber harvesting and other management practices in the watershed. Rates of erosion, landsliding, and sediment delivery to streams have exceeded natural rates compared with current conditions and can be expected to continue to exceed natural rates due to timber harvesting and the presence of roads. Excess sediment deposition, particularly by landslides and large-magnitude erosion episodes, adversely affects the maintenance of natural fluvial geomorphic processes. Over time the incidence of non-project-related erosion and landsliding affecting watershed streams should decrease somewhat due to changes in non-project-related land management practices. Improved road construction and maintenance practices adopted in the 1980s have resulted in less road-related landsliding in western Oregon. On USFS lands, the designation of Riparian Reserves adjacent to streams should reduce the future incidence of erosion and landsliding that directly affects streams, resulting in less deposition of fine sediment in stream channels. Designation of Late-Successional Reserves on a large fraction of the Western Cascades portion of the watershed (under the Northwest Forest Plan) should reduce the incidence of shallow landsliding in the watershed. Planned and ongoing watershed restoration measures in the Steamboat Creek watershed (USFS 2000a and 2000b) should reduce shallow landsliding rates and, thus, sediment delivery from this North Umpqua River tributary. However, the watersheds of Steamboat Creek and other Western Cascades tributaries contain large quantities of stored sediment and will likely continue to deliver larger-than-natural quantities of sediment to the river.

Increased timber harvesting planned in the upper portions of the watershed, primarily in the High Cascades (including Fish Creek watershed and Lemolo Reservoir unit) is likely to increase rates of sediment delivery into project canals, Lemolo Reservoir, and other project impoundments and streams with watershed in the High Cascades.

5.2 Water Quality

Water temperature increases can occur from forest canopy removal associated with logging. Increased water temperatures degrade fish habitat, especially in lower elevation streams. Warm summer water temperatures in the lower mainstem North Umpqua River are not caused by operation of the North Umpqua Project, but rather are the result of natural warming of the river and tributary inflows of warm water.

Soil in the North Umpqua River basin is naturally rich in phosphorus, and concentrations of the other commonly limiting plant nutrient, nitrogen, are increased by recreational use and timber harvest. For example, Diamond Lake, in the upper basin, is a source of nutrients from lake sediments, recreational fishing, and sewage effluents from homes and campgrounds.

5.3 Fish and Other Aquatic Biota

Non-Federal adverse impacts on coho salmon in the Action Area can come from introduced species, fisheries management, and climatic and ocean conditions (Stillwater Sciences 1998). Ocean and freshwater fisheries for coho salmon have been addressed in a separate section 7 consultation by NMFS titled “The Pacific Coast Salmon Plan and Amendment 13 to the Plan”. Therefore, fishery management is not considered here. Other possible sources of cumulative effects on coho salmon were considered to be less important to the North Umpqua basin anadromous fish stocks, including: livestock grazing, urbanization, agriculture, mining, declines in marine nutrient influx to tributaries, and mammal and avian predation.

Barriers to migration reduce distribution of anadromous fish species and may exacerbate density-dependent competition for spawning and rearing space in downstream areas. This may reduce population sizes if spawning and/or rearing habitat is limiting to the population. Barriers may also have genetic effects related to habitat fragmentation and isolation of subpopulations and may reduce variability of life history strategies. Barriers to upstream movement of fish in the North Umpqua basin include project dams and diversions (discussed in Section 4), other dams and diversions (e.g., Rock Creek Hatchery Diversion Dam), culverts and other road-stream crossings, and natural barriers such as Toketee Falls. Winchester Dam was built in 1890 on the North Umpqua River, 11 km (7 mi) upstream from its confluence with the South Umpqua River, and was raised in the 1910s and 1920s. This dam represented a complete barrier to anadromous fish migration at low flows earlier in the century, although a modified spillway allowed passage at higher flows (FCO and OSGC 1946). A fish ladder allowing passage and the counting of upstream migrating fish has been in operation since 1946.

The quantity and distribution of spawning gravels are important to the success of both resident and anadromous salmonids, including coho salmon. Activities in the North Umpqua River basin both increase and reduce spawning gravels and other sediments in the basin. Dams can reduce spawning gravel availability in downstream reaches and cause development of a coarse, relatively immobile surface layer. In the North Umpqua basin, project facilities have reduced sediment supply to downstream areas of the mainstem North Umpqua River, as described in Section 4. However, increased sediment delivery from tributaries as a result of non-Federal land management- and road-related increases erosion Cumulative reduction in bedload compared to pre-dam conditions is estimated to be about 15% where the North Umpqua River reaches Steamboat Creek, and below Steamboat Creek, bedload has increased from historical levels.

Introduced species of fish known to occur in the Umpqua River include striped bass, smallmouth bass, brown trout, and brook trout. Bass and brown trout are known to prey on juvenile salmonids, and their habitats will overlap during certain life history stages. Striped bass and smallmouth bass occur primarily downstream of the Action Area in the mainstem Umpqua River, and would be expected to primarily prey on juvenile salmonids during smolt outmigration. Brown trout occurr in the mainstem North Umpqua River and Fish Creek, and may prey on juvenile salmonids during rearing and outmigration periods.

5.4 Non-Federal Timber Harvest

Non-Federal timber harvest on private lands during the period of the new license is likely to affect coho salmon and their habitat within the Action Area. Timber harvest that occurs during the life of the new license may affect the salmonid ESUs and their habitat by increasing stream temperatures, turbidity, eutrophication, and decreasing LWD recruitment, particularly in tributaries to the North Umpqua (e.g., Rock Creek).

5.5 Hatchery Operations

The Rock Creek Hatchery is a state operated facility. Rock Creek Hatchery will likely continue to operate during the period of the new license. This hatchery propagates and releases coho salmon, summer steelhead, and spring chinook smolts into Rock Creek approximately a quarter mile from the North Umpqua River. Hatchery fish may negatively impact the OC coho ESU by competing with wild fish for rearing and spawning habitat, preying upon juvenile fish, transmitting diseases to wild fish, and reducing the genetic integrity of wild stocks from hatchery fish spawning in the wild. The total release of hatchery fish from Rock Creek Hatchery has been reduced substantially in recent years to help protect wild fish stocks and because of budget reductions. Therefore the potential adverse effects from hatchery fish will likely be reduced during the license period because fewer hatchery fish will be released compared to previous years.

ODFW currently manages the North Umpqua River coho salmon population for production of both hatchery and wild fish. Hatchery coho salmon are intended to provide harvest opportunities. Hatchery coho spawning in the wild is limited to 10% or less of the spawning population in order to protect the genetic integrity of wild coho stocks (Oregon Plan for Salmon and Watersheds 1997). Most of the hatchery coho return back to Rock Creek Hatchery; few fish stray above the confluence of Rock Creek in the North Umpqua River. The objectives in the management plan include increasing the current wild coho population to about equal the level of the 1960s (1,300 fish), and maintain about 3,500 hatchery adults at Winchester Dam. Wild coho salmon are incorporated into the hatchery brood stock to maintain similarity between hatchery and wild fish to protect the genetic integrity of this run. ODFW is currently in the process of reassessing its Wild Fish Management Policy; therefore, these policies may change in the near future.

The potential impacts to listed coho salmon from releasing hatchery summer steelhead and spring chinook are likely to be very low in the action area. These hatchery fish are released as smolts and actively emigrate out of the action area towards the ocean in less than one day. The potential for predation and/or competition with coho salmon in the action area is therefore low. Hatchery summer steelhead and spring chinook adults do not interact with returning coho salmon because of different run timing.

5.6 Recreation

A variety of recreational opportunities are available in the watershed, including boating, fishing, hunting camping, hiking, and others. Regulated fishing for salmon, steelhead, trout occur in the North Umpqua basin. Fishing may affect the OC coho ESU, but regulations enforced by the State of Oregon are likely sufficient enough that recreational fishing will not threaten the persistence of the species. Recreational use of Project roads for hunting and camping may cause impacts on coho salmon by increasing sediment delivery to streams. Although use of the roads is likely to continue through the period of the new license, the net cumulative impact is not likely to be significant.

5.7 Urban and Rural Development

Urban and rural development can contribute to riparian habitat fragmentation, water quality degradation (especially from non-point sources), and other impacts to listed wildlife and salmonid species. There are no urban areas within the Project vicinity. Much of the North

Umpqua basin downstream of the Project is used for agriculture. The effects of agriculture and other rural development on listed species in the North Umpqua basin will likely continue at current levels through the period of the new license. It is unlikely that rural development within the North Umpqua basin will threaten the persistence of listed species occurring there.

6. CONCLUSIONS

The final step in NOAA Fisheries' approach to determining whether the proposed action jeopardizes the continued existence of listed species is to determine whether the proposed action, in light of the above factors, is likely to appreciably reduce the likelihood of species survival in the wild. NOAA Fisheries has determined that, when the effects of the proposed action are added to the environmental baseline and cumulative effects occurring in the Action Area, given the status of the stocks and condition of important habitat features, the action is not likely to jeopardize the continued existence of the OC coho salmon.

This conclusion is based on NOAA Fisheries' determination that most aspects of the proposed action are not likely to impair properly functioning habitat, reduce appreciably the functioning of already impaired habitat, or retard the long-term progress of impaired habitat towards properly functioning condition (Table 8).

For those Project activities or features that are expected to reduce, retard, or impair habitat conditions, the effects are largely mitigated by short duration or by an expectation that few OC coho salmon will be exposed to or affected by them. For example, continued blocked passage at Soda Springs Dam is limited to the first seven years of the license (while passage facilities are being designed, constructed, and tested) and, because habitat above Soda Springs is marginal for coho and at the limit of their historical distribution, this effect should have a minor impact on the local population of this ESU. Similarly, few OC coho salmon are likely to be affected by the continuing loss of spawning and rearing habitat, and increased juvenile predation, caused by the presence of Soda Springs Reservoir.

This conclusion is also based on NOAA Fisheries' understanding that ongoing project operations and conservation measures contained in the FERC's DEIS measures are expected to increase coho salmon spawning and rearing habitat quantity and quality in the Action Area in both the short- and long- term, which should increase overall production in the basin. These actions include improvement of passage and habitat in the Rock Creek basin, an area that is much more accessible to OC coho salmon than the Project area above Soda Springs Dam. These improvements should result in increased survival and productivity of the local population of this ESU.

Finally, this conclusion is based on the finding that nearly every aspect of proposed Project operation and configuration represents a reduction or elimination of historical adverse effects of the Project, which influenced the habitat condition and species status under the environmental baseline (Table 8). While a continuation of historical Project configuration and operation is explicitly excluded from the environmental baseline in the analysis of effects, these changes are likely to result in improved status of the local population of this ESU.

7. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of threatened and endangered species. Conservation recommendations are discretionary measures suggested to minimize or avoid adverse effects of a proposed action on listed species, to minimize or avoid adverse modification of critical habitat, or to develop additional information. NOAA Fisheries has no conservation recommendations to make at this time.

8. REINITIATION OF CONSULTATION

As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

NOAA Fisheries and PacifiCorp have entered into the Agreement to facilitate issuance of a New License for the Project, and to finally resolve resource-related issues pertaining to the New License. FERC's DEIS contemplates incorporation of this Agreement into a final license order and license articles for the Project. In the event that final license fails to incorporate the requirements of the Agreement analyzed in this biological opinion, FERC may be required to reinitiate consultation under section 7 of the ESA.

9. INCIDENTAL TAKE STATEMENT

Sections 4 (d) and 9 of the ESA prohibit any taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct) of listed species without a specific permit or exemption. Harm is further defined in 50 CFR §222.102 as "an act that may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering." Harass is defined as actions that create the likelihood of injuring listed species to such an extent as to significantly alter normal behavior patterns which include, but are not limited to, breeding, feeding, and sheltering. Incidental take is take of listed species that results from, but is not the purpose of, the Federal agency or the applicant carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to, and not intended as part of, the agency action is not considered prohibited taking provided that such taking is in compliance with the terms and conditions of this incidental take statement.

An incidental take statement specifies the impact of any incidental taking of endangered or threatened species. It also provides reasonable and prudent measures that are necessary to minimize impacts and sets forth terms and conditions with which the action agency must comply in order to implement the reasonable and prudent measures.

9.1 Amount and Extent of Anticipated Take

NOAA Fisheries anticipates that the proposed action will cause more than a negligible amount of incidental take of OC coho salmon for the reasons presented in this biological opinion. Take can be quantified for juveniles using the downstream bypass facility at Soda Springs Dam (Table 7). For that proportion of the population exposed to the bypass, smolt and fry mortality of up to 2% and injuries of up to 4% for smolts and 6% for fry is anticipated. Other take examples may include juvenile harm or mortality caused by stranding in some Project reaches under emergency conditions, delay or injury during adult and juvenile passage at Soda Springs Dam, and mortality of juveniles caused by predation in Soda Springs Reservoir. Despite the use of best scientific and commercial data available, NOAA Fisheries cannot quantify a specific amount of incidental take or individual fish or incubating eggs for this action.

Instead, the extent of take is anticipated to be that associated with the operation of the Project in accordance with the measures of the preferred alternative in the DEIS pursuant to a New License issued by FERC. The DEIS preferred alternative measures are described in Section 2 of this biological opinion.

9.2 Effect of Anticipated Take

As analyzed in this opinion and described in Section 6.0, NOAA Fisheries has determined that this extent of anticipated take is not likely to jeopardize the continued existence of OC coho salmon.

9.3 Reasonable and Prudent Measures

Reasonable and Prudent Measures are non-discretionary measures to minimize take, that are not already part of the description of the proposed action. They must be implemented as binding conditions for the exemption in section 7(a)(2) to apply. FERC has the continuing duty to regulate the activities covered in this incidental take statement. If FERC fails to require the applicants to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, or fails to retain the oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse. NOAA Fisheries believes that activities carried out in a manner consistent with these reasonable and prudent measures, except those otherwise identified, will not necessitate further site-specific consultation. Activities which do not comply with all relevant reasonable and prudent measures will require further consultation.

NOAA Fisheries believes that the following reasonable and prudent measures (RPM) are necessary and appropriate to minimize the effect of anticipated incidental take of OC coho salmon. FERC must require PacifiCorps to:

1. Minimize the likelihood of incidental take associated with Project operations by providing adequate instream flows, minimizing flow fluctuations, managing riparian vegetation, and controlling erosion and sediment.

2. Minimize the likelihood of incidental take from construction activities in or near watercourses by restricting instream work to recommended time periods, implementing pollution and erosion control measures, and avoiding or replacing lost riparian and instream functions.

3. Mitigate the effect of incidental take by providing fish passage to upstream habitat, and minimize incidental take associated with downstream fish passage at diversions by providing fish screens.

4. Mitigate the effect of incidental take by restoring fluvial geomorphic processes, enhancing spawning habitat, providing additional aquatic connectivity, providing access to upstream habitat, and funding tributary enhancement and other mitigation measures.

5. Monitor the effectiveness of the proposed protection, minimization and enhancement measures in minimizing the effect of incidental take and report monitoring results to NOAA Fisheries.

9.4 Terms and Conditions

In order to be exempt from the take prohibitions of section 9 of the ESA and regulations issued pursuant to section 4(d) of the ESA, FERC must include in the New License and PacifiCorp must implement the following terms and conditions, which implement the RPMs listed above. These terms and conditions are non-discretionary.

9.4.1 Instream Flows, Flow Fluctuations, Riparian Vegetation, Erosion and Sediment Control

To Implement RPM No. 1, above, FERC must require PacifiCorps to:

a. Implement the minimum instream flow measures identified in Sections 5.1 through 5.9 and Tables 1 and 2 of Appendix C of the SA. (DEIS Section 3.4.2.1, p. 3-76).

b. Implement the ramping measures identified in Sections 6.1 through 6.9 of the SA. (DEIS Section 3.4.2.2, p. 3-85).

c. Ensure that ramping criteria (established in section 6.4 of the SA) for the Wild and Scenic River reach are maintained during emergency shutdowns. In accordance with section 6.8 of the SA, this is to happen via necessary measures to achieve this requirement, including, but not limited to, installing a new bypass valve or improving the existing valve at Soda Springs powerhouse by the date the new license becomes final or 2004, whichever is earlier.

d. Develop and implement a vegetation management plan in accordance with Section 12.1 of the SA, including in the plan measures set forth in Section 9.4.2(n) – (q) of these terms and conditions. (DEIS Section 3.5.2.1, p. 3-123).

e. Implement noxious-weed control measures in accordance with Section 12.2 of the SA. (DEIS Section 3.5.2.1, p. 3-123 to 3-126).

f. Implement erosion- and sediment-control measures in accordance with Sections 14.1 through 14.8 of the SA. (DEIS Section 3.2.2.1, p. 3-18 to 3-23).

g. Perform road and bridge decommissioning in accordance with Sections 15.1 through 15.5.1 of the SA. (DEIS Section 3.10.2.2, p. 3-211 to 3-215).

9.4.2 Construction Activities In or Near Watercourses

To Implement RPM No. 2, above, FERC must require PacifiCorp to:

a. All in-water work occurring on the downstream side of Soda Springs Dam shall be completed within the work period of July 1 and September 15.

b. No in-water work on the downstream side of Soda Springs Dam shall take place outside this work period without prior written authorization from NOAA Fisheries, in consultation with the Oregon Department of Fish and Wildlife ("ODFW").

c. Construction activities associated with habitat enhancement and erosion control measures shall meet or exceed best management practices and other performance standards contained in the Oregon Department of Environmental Quality for the National Pollutant Discharge Elimination System ("NPDES") 1200-CA permit (General NPDES Stormwater Discharge Permit).

d. All erosion control devices shall be inspected weekly, at a minimum, during construction to ensure that they are working adequately.

e. Erosion control materials (e.g., silt fence, straw bales, aggregate) in excess of those installed shall be available on site for immediate use during emergency erosion control needs.

f. Vehicles operated within 150 ft of the waterway are free of fluid leaks. Daily examination of vehicles for fluid leaks is required during periods operated within or above the waterway.

g. During completion of habitat enhancement activities, no pollutants of any kind (sewage, waste spoils, petroleum products, etc.) shall come in contact with the water body or wetlands nor their substrate below the mean high-high water elevation or 10-year flood elevation, whichever is greater.

h. Any areas used for staging, access roads, or storage are to be evacuated and all materials, equipment, and fuel shall be removed if flooding of the area is expected to occur within 24 hours.

i. Vehicle maintenance, re-fueling of vehicles and storage of fuel shall be done at least 150 ft from the waterway.

j. At the end of each work shift, vehicles shall not be stored within or over the waterway.

k. Prior to operating within the waterway, all equipment shall be cleaned of external oil, grease, dirt or caked mud. Any washing of equipment shall be conducted in a location that shall not contribute untreated wastewater to any flowing stream or drainage area.

l. Temporary erosion and sediment controls will be used on all exposed slopes during any hiatus in work exceeding 7 days.

m. Material removed during excavation will only be placed in locations where it cannot enter sensitive aquatic resources. Whenever topsoil is removed, it shall be stored and reused on-site to the greatest extent possible.

n. Alteration or disturbance of the stream banks and existing riparian vegetation will be minimized to the greatest extent possible.

o. No herbicide application shall occur as part of this action. Mechanical removal of undesired vegetation and root nodes is permitted.

p. Clearing limits shall be identified and marked. Construction activity or movement of equipment into existing vegetated areas shall not begin until clearing limits are marked.

q. All existing vegetation within 150 ft of the edge of bank, downstream from Soda Springs Dam should be retained to the greatest extent possible.

9.4.3 Fish Passage

To Implement RPM No. 3, above, FERC must require PacifiCorp to:

a. Provide upstream fish passage at Soda Springs Dam in accordance with Section 4.1.1 of the SA. (DEIS Section 3.4.2.3, p. 3-93 to 3-95)

b. Provide fish screens at Soda Springs Dam for downstream fish passage in accordance with Section 4.1.2 of the SA. (DEIS Section 3.4.2.3, p. 3-93 to 3-95)

c. Implement changes to Soda Springs Dam operations or facilities if performance standards listed in Appendix B, Part 1, Table 1 of the SA are not met during a post-construction evaluation period, in accordance with Section 4.1.2(e) of the SA. (DEIS Section 3.4.2.3, p. 3-95) Such changes may include:

   i. Improved hydraulic balancing of screens or structural modifications;
   ii. construction of additional screening facilities;
   iii. seasonal shutdowns of turbines; or
   iv. reductions in flow diversions.

d. Install a fish screen at the Fish Creek intake which meets ODFW's March 2001 screen design criteria in accordance with Section 4.3.2(a) and Appendix B, Part 2 of the SA. (DEIS Section 3.4.2.3, p. 3-96).

9.4.4 Fluvial Geomorphic Processes, Spawning Habitat, Aquatic Connectivity, Tributary Enhancement, and Other Mitigation Measures

To Implement RPM No. 4, above, FERC must require PacifiCorp to:

a. Implement gravel augmentation, woody debris and sediment passage measures in accordance with Sections 7.1 through 7.4 of the SA. (DEIS Section 3.2.2.2, p.3-24 to 3-27).

b. Reconnect the Clearwater River to the Toketee bypass reach in accordance with Section 7.5 of the SA. (DEIS Section 3.4.2.7, p.3-112).

c. Perform spawning habitat enhancement measures in accordance with Sections 8.1 through 8.3.5 of the SA. (DEIS Section 3.4.2.5, p.3-105 to 3-106).

d. Improve aquatic connectivity in accordance with Sections 10.1 through 10.7 of the SA. (DEIS Section 3.4.2.7, p.3-112 to 3-113).

e. Perform culvert upgrades in accordance with Section 15.6 of the SA.

f. Fund tributary enhancement, long-term monitoring and predator control plans, a mitigation fund and an early implementation fund in accordance with Sections 19.1 through 19.5.4 of the SA.

9.4.5 Monitoring

To Implement RPM No. 5, above, FERC must require PacifiCorp to:

a. Monitor the effectiveness of the proposed protection, minimization and enhancement measures in accordance with the scope and schedules of Sections 4.1.1(b) and (d); 4.1.2(b); 4.3.1(c) and (d); 4.3.2(b); 6.2.1; 8.2.2; 8.3.3; 14.5; and 19.4.1 of the SA, and provide results of such monitoring to NOAA Fisheries as required in those sections.

b. Provide NOAA Fisheries with post-construction monitoring reports of erosion control measures required by terms and conditions set forth in Section 9.4.2, above, and include:

   i. A narrative describing the nature of best management practices implemented to reduce erosion for habitat enhancement actions.

   ii. A narrative describing any failures experienced with erosion control measures and efforts made to correct them.

10. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

10.1 Background

The MSA, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established procedures designed to identify, conserve, and enhance EFH for those species regulated under a Federal fisheries management plan. Pursuant to the MSA:

Federal agencies must consult with NOAA Fisheries on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH (§305(b)(2));
NOAA Fisheries must provide conservation recommendations for any Federal or State action that would adversely affect EFH (§305(b)(4)(A)); Federal agencies must provide a detailed response in writing to NOAA Fisheries within 30 days after receiving EFH conservation recommendations. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with NOAA Fisheries EFH conservation recommendations, the Federal agency must explain its reasons for not following the recommendations (§305(b)(4)(B)).

EFH means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (MSA §3). For the purpose of interpreting this definition of EFH: Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle (50 CFR §600.10). Adverse effect means any impact which reduces quality and/or quantity of EFH, and may include direct (*e.g.*, contamination or physical disruption), indirect (*e.g.*, loss of prey or reduction in species fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR §600.810).

EFH consultation with NOAA Fisheries is required regarding any Federal agency action that may adversely affect EFH, including actions that occur outside EFH, such as certain upstream and upslope activities.

The objectives of this EFH consultation are to determine whether the proposed action would adversely affect designated EFH and to recommend conservation measures to avoid, minimize, or otherwise offset potential adverse effects to EFH.

10.2 Identification of EFH

Pursuant to the MSA the Pacific Fisheries Management Council (PFMC) has designated EFH for three species of Federally-managed Pacific salmon: chinook (*Oncorhynchus tshawytscha*); coho (*O. kisutch*); and Puget Sound pink salmon (*O. gorbuscha*) (PFMC 1999). Take of these species, chinook salmon and coho salmon, are affected by the proposed action. Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable man-made barriers (as identified by the PFMC 1999), and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years). Detailed descriptions and identifications of EFH for salmon are found in Appendix A to Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999). Assessment of potential adverse effects to these species' EFH from the proposed action is based, in part, on this information.

10.3 Proposed Actions

The proposed action and Action Area are detailed above in Section 2 of this biological opinion. The Action Area includes habitats that have been designated as EFH for various life-history stages of coho salmon and chinook salmon.

10.4 Potential Effects of the Proposed Action on Chinook Salmon

Potential adverse effects of the proposed action were described in relation to coho salmon, but are expected to similarly apply to chinook salmon, and include:

- Soda Springs Dam will continue to block access to 6.6 mi of spawning and rearing habitat for seven years following license approval; will result in some delay or injury to adults and juveniles passing the Project after passage is established in year seven; will retain coarse sediment, which may reduce the availability of spawning gravel downstream of Soda Springs Dam (largely mitigated by gravel augmentation below the Project); and will continue to inundate potential spawning and rearing habitat and serves as a refuge for resident trout that may prey on juvenile salmonids passing through the reservoir (largely mitigated by predator control program).

- Slide Creek Dam will continue to block access to 1.2 mi of potential spawning and rearing habitat for the duration of the license (largely mitigated by off-site habitat improvement in the Rock Creek area).

- Soda Springs, Slide Creek, and Fish Creek diversions will continue to reduce flows in bypass reaches (partially mitigated by minimum flow levels that maintain a high percentage of useable habitat and reduce impacts of diversions on temperature).

- Construction effects related to culvert replacement, construction of adult fish ladders and juvenile screens, which may increase short-term erosion, turbidity, and other in-water effects (largely mitigated by requirement for NOAA Fisheries approval of construction plans).

10.5 Conclusion

NOAA Fisheries concludes that the proposed action would adversely affect designated EFH for coho salmon and chinook salmon.

10.6 EFH Conservation Recommendations

Pursuant to Section 305(b)(4)(A) of the MSA, NOAA Fisheries is required to provide EFH conservation recommendations to Federal agencies regarding actions which may adversely affect EFH. While NOAA Fisheries understands that the conservation measures described in the Biological Assessment will be implemented by FERC and, through its license PacifiCorps, it does not believe that these measures are sufficient to address the adverse impacts to EFH described above. However, the Terms and Conditions outlined in Section 9.0 are generally applicable to designated EFH for coho salmon and chinook salmon, and address these adverse effects. Consequently, NOAA Fisheries recommends that they be adopted as EFH conservation measures.

10.7 Statutory Response Requirement

Pursuant to the MSA (§305(b)(4)(B)) and 50 CFR §600.920(j), Federal agencies are required to provide a detailed written response to NOAA Fisheries' EFH conservation recommendations within 30 days of receipt of these recommendations. The response must include a description of measures proposed to avoid, mitigate, or offset the adverse impacts of the activity on EFH. In the case of a response that is inconsistent with the EFH conservation recommendations, the response must explain the reasons for not following the recommendations, including the scientific justification for any disagreements over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects.

10.8 Supplemental Consultation

FERC must reinitiate EFH consultation with NOAA Fisheries if the proposed action is substantially revised in a manner that may adversely affect EFH, or if new information becomes available that affects the basis for NOAA Fisheries' EFH conservation recommendations (50 CFR §600.920(k)).

11. LITERATURE CITED

Allen, K. R. 1969. Limitations on production in salmonid populations in streams. T. G. Northcote, editor. Symposium on salmon and trout in streams. H. R. MacMillan Lectures in Fisheries, University of British Columbia, Vancouver.

Anderson, C. W., and K. D. Carpenter. 1996. Investigation of water quality and algae, and relations to resource management in the North Umpqua River basin, Oregon, 1992-95. Unpublished Water-Resources Investigations Report. U. S. Geological Survey, Portland, Oregon.

Andrus, C. W., B. A. Long, and H. A. Froehlich. 1988. Woody debris and its contribution to pool formation in a coastal stream 50 years after logging. Canadian Journal of Fisheries and Aquatic Sciences 45: 2080-2086.

Bakken, L. J. 1970. Lone Rock Free State: a collection of historical adventures and incidents in Oregon's North Umpqua Valley, 1850 to 1910. Mail Printers.

Barnhart, R. A. 1991. Steelhead *Oncorhynchus mykiss*. Pages 324-336 *in* J. Stolz and J. Schnell, editors. Trout. Stackpole Books, Harrisburg, Pennsylvania.

Bauer, J. A., D. M. Anderson, and R. Temple. 1979. The Umpqua River striped bass. Southwest Region Information Report 78-1. Oregon Department of Fish and Wildlife, Fish Division.

Bauersfeld, K. 1978. The effect of daily flow fluctuations on spawning fall chinook in the Columbia River. Technical Report 38. Washington State Department of Fisheries, Olympia.

Beacham, T. D., and C. B. Murray. 1990. Temperature, egg size, and development of embryos and alevins of five species of Pacific salmon: a comparative analysis. Transactions of the American Fisheries Society 119: 927-945.

Bell, M. C. 1973. Fisheries handbook of engineering requirements and biological criteria. Contract DACW57-68-C-0086. Fisheries-Engineering Research Program, U. S. Army Corps of Engineers, North Pacific Division, Portland, Oregon.

Bell, M. C., editor. 1986. Fisheries handbook of engineering requirements and biological criteria. Report No. NTIS AD/A167-877. Fish Passage Development and Evaluation Program, U. S. Army Corps of Engineers, North Pacific Division, Portland, Oregon.

Bell, M. C., editor. 1991. Fisheries handbook of engineering requirements and biological criteria. Fish Passage Development and Evaluation Program, U. S. Army Corps of Engineers, North Pacific Division, Portland, Oregon.

Benda, L. 1994. Stochastic geomorphology in a humid mountain landscape. Doctoral dissertation. University of Washington, Seattle.

Berg, L. 1982. The effect of exposure to short-term pulses of suspended sediment on the behavior of juvenile salmonids. Pages 177-196 *in* G. F. Hartman, editor. Proceedings of the Carnation Creek workshop: a ten-year review. Pacific Biological Station, Nainamo, British Columbia.

Berg, L., and T. G. Northcote. 1985. Changes in territorial, gill-flaring and feeding behavior in juvenile coho salmon (*Oncorhynchus kisutch*) following short-term pulses of suspended sediment. Canadian Journal of Fisheries and Aquatic Sciences 42: 1410-1417.

Beschta, R. L., R. E. Bilby, G. W. Brown, L. B. Holtby, and T. D. Hofstra. 1987. Stream temperature and aquatic habitat: fisheries and forestry interactions. Pages 191-232 *in* E. O. Salo and T. W. Cundy, editors. Streamside management: forestry and fishery interactions. Contribution No. 57. College of Forest Resources, University of Washington, Seattle.

Bilby, R. E., and P. A. Bisson. 1992. Allochthonous versus autochthonous organic matter contributions to the trophic support of fish populations in clear-cut and old-growth forested streams. Canadian Journal of Fisheries and Aquatic Sciences 49: 540-551.

Bilby, R. E., B. R. Fransen, and P. A. Bisson. 1996. Incorporation of nitrogen and carbon from spawning coho salmon into the trophic system of small streams: evidence from stable isotopes. Canadian Journal of Fisheries and Aquatic Sciences 53: 164-173.

Bilby, R. E., B. R. Fransen, P. A. Bisson, and J. K. Walter. 1998. Response of juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead (*Oncorhynchus mykiss*) to the addition of salmon carcasses to two streams in southwestern Washington, U. S. A. Canadian Journal of Fisheries and Aquatic Sciences 55: 1909-1918.

Bisson, P. A., and J. R. Sedell. 1984. Salmonid populations in streams in clear-cut vs. old-growth forests of western Washington. Pages 121-129 *in* W. R. Meehan, T. R. Merrell, Jr. and T. A. Hanley, editors. Fish and wildlife relationships in old-growth forests. American Institute of Fishery Research Biologists, Juneau, Alaska.

Bisson, P. A., and R. E. Bilby. 1982. Avoidance of suspended sediment by juvenile coho salmon. North American Journal of Fisheries Management 4: 371-374.

Bjornn, T. C., and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83-138 *in* W. R. Meehan, editor. Influences of forest and rangeland management on salmonid fishes and their habitats. Special Publication No. 19. American Fisheries Society, Bethesda, Maryland.

Botkin, D. B., K. Cummins, T. Dunne, H. Regier, M. Sobel, L. M. Talbot, and L. Simpson. 1995. Status and future of salmon of western Oregon and northern California: overview of findings and options. Research Report 951002. The Center for the Study of the Environment, Santa Barbara, California.

Bottom, D. L., T. E. Nickelson, and S. L. Johnson. 1986. Research and development of Oregon's coastal salmon stocks: coho salmon model. Annual Progress Report AFC-127. Oregon Department of Fish and Wildlife, Portland, Oregon.

Bouck, G. R. 1980. Etiology of gas bubble disease. Transactions of the American Fisheries Society 109: 703-707.

Brett, J. R. 1952. Temperature tolerance in young Pacific salmon, genus *Oncorhynchus*. Journal of the Fisheries Research Board of Canada 9: 265-323.

Brauner, D., and W. Honey. 1977. Cultural resource evaluation of the Steamboat Creek drainage, Douglas County, Oregon. Prepared by Department of Anthropology, Oregon State University, Corvallis for USDA Forest Service, Umpqua National Forest, Glide, Oregon.

Brown, G. W., G. W. Swank, and J. Rothacher. 1971. Water temperature in the Steamboat drainage. Research Paper PNW-119. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Bruton, M. N. 1985. The effects of suspensoids on fish. Hydrobiologia 125: 221-241.

Bugert, R. M., and T. C. Bjornn. 1991. Habitat use by steelhead and coho salmon and their responses to predators and cover in laboratory streams. Transactions of the American Fisheries Society 120: 486-493.

Chamberlin, T. W., R. D. Harr, and F. H. Everest. 1991. Timber harvesting, silviculture, and watershed processes. Pages 181-205 *in* W. R. Meehan, editor. Influences of forest and rangeland management on salmonid fishes and their habitats. Special Publication No. 19. American Fisheries Society, Bethesda, Maryland.

Chapman, D. W. 1966. Food and space as regulators of salmonid populations in streams. The American Naturalist 100: 345-357.

Chapman, D. W., and E. Knudsen. 1980. Channelization and livestock impacts on salmonid habitat and biomass in western Washington. Transactions of the American Fisheries Society 109: 357-363.

Chilcote, M. W. 1998. Conservation status of steelhead in Oregon. Information Reports No. 98-3. Oregon Department of Fish and Wildlife, Portland, Oregon.

Chutter, F. M. 1969. The effects of silt and sand on the invertebrate fauna of streams and rivers. Hydrobiologia 34: 57-76.

Clare, H. C., and R. B. Marston. 1968. Forestry practices in the North Umpqua River basin, Oregon. Report submitted to Federal Water Pollution Control Administration, U. S. Department of the Interior, Northwest Regional Office, Portland, Oregon.

Cloern, J. E. 1976. The survival of coho salmon (*Oncorhynchus kisutch*) eggs in two Wisconsin tributaries of Lake Michigan. The American Midland Naturalist 96: 451-461.

Coats, R. N., R. L. Leonard, and C. R. Goldman. 1976. Nitrogen uptake and release in a forested watershed, Lake Tahoe Basin, California. Ecology 57: 995-1004.

Cobb, J. N. 1930. Pacific salmon fisheries. Report of the U. S. Commission of Fisheries 1930, Bureau of Fisheries Document No. 1092. U. S. Bureau of Fisheries.

Columbia Basin Environmental. 2001. North Umpqua River total dissolved gas study, 10 to 13 September 2001. Prepared for PacifiCorp, Portland, Oregon.

Cordone, A. J., and D. W. Kelley. 1961. The influences of inorganic sediment on the aquatic life of streams. California Fish and Game 47: 189-228.

Coutant, C. C., and R. G. Genoway. 1968. Final report on an exploratory study of interaction of increased temperature and nitrogen supersaturation on mortality of adult salmonids to U. S. Bureau of Commercial Fisheries, Seattle, Washington. Battelle Memorial Institute Pacific Northwest Laboratory, Richland, Washington.

Cushman, R. M. 1985. Review of ecological effects of rapidly varying flows downstream from hydroelectric facilities. North American Journal of Fisheries Management 5: 330-339.

Daily, K. 1992. Smallmouth bass predation on indigenous fish species in the Umpqua, Rogue, and John Day river basins. Oregon Department of Fish and Wildlife.

Dambacher, J. M. 1991. Distribution, abundance, and emigration of juvenile steelhead (*Oncorhynchus mykiss*), and analysis of stream habitat in the Steamboat Creek basin, Oregon. Master's thesis. Oregon State University, Corvallis.

Davidson, F. A., and S. J. Hutchinson. 1938. The geographic and environmental limitations of the Pacific salmon (genus *Oncorhynchus*). Bulletin of the Bureau of Fisheries (U. S.) 48: 667-692.

Davis, J. C. 1975. Minimal dissolved oxygen requirements of aquatic life with emphasis on Canadian species: a review. Journal of the Fisheries Research Board of Canada 32: 2295-2332.

Dawley, E. M., and W. J. Ebel. 1975. Effects of various concentrations of dissolved atmospheric gas on juvenile chinook salmon and steelhead trout. Fishery Bulletin 73: 787-796.

Dawley, E., B. Monk, M. Schiewe, F. Ossiander, and W. Ebel. 1976. Salmonid bioassay of supersaturated dissolved air in water. EPA-600/376-056. U. S. Environmental Protection Agency, Duluth, Minnesota.

Dose, J. J., and B. B. Roper. 1994. Long-term changes in low-flow channel widths within the South Umpqua watershed, Oregon. Water Resources Bulletin 30: 993-1000.

Dose, J. J. 2000. North Umpqua hydropower relicensing: flow fluctuation investigations of the North Umpqua River during the period 6/28-29/2000. Letter to B. Rios, Acting Forest

Supervisor and D. Ostby, Forest Re-licensing Representative, USDA Forest Service, Umpqua National Forest, Roseburg, Oregon from J. J. Dose, Forest Fish Biologist, Umpqua National Forest. 17 July.

Ebel, W. J. 1970. Effect of release location on survival of juvenile fall chinook salmon, *Oncorhynchus tshawytscha*. Transactions of the American Fisheries Society 99: 672-676.

Ebel, W. J., and H. L. Raymond. 1976. Effect of atmospheric gas saturation on salmon and steelhead trout of the Snake and Columbia rivers. U. S. National Marine Fisheries Service, Marine Fisheries Review 7 (or 38): 1-14.

Eilers, J. M., and R. Raymond. 2001. North Umpqua River water quality and paleolimnological analysis. Prepared by J. C. Headwaters, Inc., Bend, Oregon for PacifiCorp, Portland, Oregon.

Everest, F. H., G. H. Reeves, J. R. Sedell, J. Wolfe, D. Hohler, and D. A. Heller. 1986. Abundance, behavior, and habitat utilization by coho salmon and steelhead trout in Fish Creek, Oregon, as influenced by habitat enhancement. Annual Report 1985 Project No. 84-11. Prepared by U. S. Forest Service for Bonneville Power Administration, Portland, Oregon.

FCO and OSGC (Fish Commission of Oregon and Oregon State Game Commission). 1946. The Umpqua River study. Joint report.

FERC (Federal Energy Regulatory Commission). 2002a. North Umpqua Hydroelectric Project, Oregon (FERC Project No. 1927). Draft Environmental Impact Statement FERC/DEIS - 0147D. FERC, Office of Energy Projects, Washington, D. C.

FERC (Federal Energy Regulatory Commission). 2002b. North Umpqua Hydroelectric Project draft biological assessment and essential fish habitat assessment. FERC, Office of Energy Projects, Washington, D. C.

Fredricksen, R. L. 1971. Comparative water quality--natural and disturbed streams. Pages 125-137 *in* J. T. Krygier and J. D. Hall, editors. Proceedings of the symposium on forest land uses and the stream environment. Oregon State University, Corvallis.

Fresh, K. L. 1997. The role of competition and predation in the decline of Pacific salmon and steelhead. Pages 245-275 *in* D. J. Stouder, P. A. Bisson and R. J. Naiman, editors. Pacific salmon and their ecosystems: status and future options. Chapman and Hall, NY.

Gharrett, J. T., and J. I. Hodges. 1950. Salmon fisheries of the coastal rivers of Oregon south of the Columbia. Contribution No. 13. Oregon Fish Commission, Portland.

Glova, G. J. 1986. Interaction for food and space between experimental populations of juvenile coho salmon (*Oncorhynchus kisutch*) and coastal cutthroat trout (*Salmo clarki*) in a laboratory stream. Hydrobiologia 132: 155-168.

Godfrey, H. 1965. Coho salmon in offshore waters. *In* Salmon of the North Pacific Ocean. Part IX. Coho, chinook and masu salmon in offshore waters. International North Pacific Fisheries Commission Bulletin 16 16: 1-39.

Gradall, K. S., and W. A. Swenson. 1982. Responses of brook trout and creek chubs to turbidity. Transactions of the American Fisheries Society 111: 392-395.

Greene, J. C., W. E. Miller, T. Shiroyama, and M. Knittel. 1996. Evaluation of the effects of forest management on water quality in the South Umpqua Experimental Forest watershed, Oregon. Abstracts of the Chapman conference on nitrogen cycling in forested catchments. American Geophysical Union.

Grette, G. B. 1985. The role of large organic debris in juvenile salmonid rearing habitat in small streams. Master's thesis. University of Washington, Seattle.

Gregory, R. S., and T. G. Northcote. 1993. Surface, planktonic, and benthic foraging by juvenile chinook salmon (*Oncorhynchus tshawytscha*) in turbid laboratory conditions. Canadian Journal of Fisheries and Aquatic Sciences 50: 233-240.

Griffiths, J. S., and D. F. Alderdice. 1972. Effects of acclimation and acute temperature experience on the swimming speed of juvenile coho salmon. Journal of the Fisheries Research Board of Canada 29: 251-264.

Gross, M. R. 1991. Salmon breeding behavior and life history evolution in changing environments. Ecology 72: 1180-1186.

Grost, R. T., and M. B. Bonoff. 1997. Measurement of intergravel dissolved oxygen in salmonid redds. Poster session at 1997 Oregon Chapter Meeting of American Fisheries Society, Salishan Lodge, Oregon.

Hall, J. D., and R. L. Lantz. 1969. Effects of logging on the habitat of coho salmon and cutthroat trout in coastal streams. Pages 355-375 *in* T. G. Northcote, editor. Symposium on salmon and trout in streams. H. R. MacMillan Lectures in Fisheries, University of British Columbia, Vancouver.

Hartman, G. F., B. C. Andersen, and J. C. Scrivener. 1982. Seaward movement of coho salmon (*Oncorhynchus kisutch*) fry in Carnation Creek, an unstable coastal stream in British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 39: 588-597.

Hartman, G. F., L. B. Holtby, and J. C. Scrivener. 1984. Some effects of natural and logging-related winter stream temperature changes on the early life history of coho salmon (*Oncorhynchus kisutch*) in Carnation Creek, British Columbia. Pages 141-150 *in* W. R. Meehan, T. R. Merrell, Jr. and T. A. Hanley, editors. Fish and wildlife relationships in old-growth forests. American Institute of Fishery Research Biologists, Juneau, Alaska.

Hartman, G. F., J. C. Scrivener, L. B. Holtby, and L. Powell. 1987. Some effects of different streamside treatments on physical conditions and fish population processes in Carnation Creek, a coastal rain forest stream in British Columbia. Pages 330-372 *in* E. O. Salo and T. W. Cundy, editors. Streamside management: forestry and fishery interactions. College of Forest Resources, University of Washington.

Hartman, G. F., and J. C. Scrivener. 1990. Impacts of forestry practices on a coastal stream ecosystem, Carnation Creek, British Columbia. Canadian Bulletin of Fisheries and Aquatic Sciences 223: 148 pp.

Harza and RTG Fishery Research. 2000. 1999 Controlled flow study: North Umpqua Hydroelectric Project, FERC Project No. 1927. Prepared for PacifiCorp, Portland, Oregon.

Hayes, J. W. 1987. Competition for spawning space between brown (*Salmo trutta*) and rainbow trout (*S. gairdneri*) in a lake inlet tributary, New Zealand. Canadian Journal of Fisheries and Aquatic Sciences 44: 40-47.

Healey, M. C. 1991. Life history of chinook salmon (*Oncorhynchus tshawytscha*). Pages 311-393 *in* C. Groot and L. Margolis, editors. Pacific salmon life histories. University of British Columbia Press, Vancouver, British Columbia.

Holaday, S. 1992. Summertime water temperatures in Steamboat Creek basin, Umpqua National Forest. Master's thesis. Oregon State University, Corvallis.

Holtby, L. B. 1988. Effects of logging on stream temperatures in Carnation Creek, British Columbia, and associated impacts on the coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Sciences 45: 502-515.

House, R. A., and P. L. Boehne. 1987. The effect of stream cleaning on salmonid habitat and populations in a coastal Oregon drainage. Western Journal of Applied Forestry 2: 84-87.

House, R., V. Crispin, and J. M. Suther. 1991. Habitat and channel changes after rehabilitation of two coastal streams in Oregon. American Fisheries Society Symposium 10: 150-159.

Hunter, M. A. 1992. Hydropower flow fluctuations and salmonids: a review of the biological effects, mechanical causes, and options for mitigation. Technical Report No. 119. State of Washington Department of Fisheries, Olympia.

Johnson, O. W., R. S. Waples, T. C. Wainwright, K. G. Neely, F. W. Waknitz, and L. T. Parker. 1994. Status review for Oregon's Umpqua River sea-run cutthroat trout. NOAA Technical Memorandum NMFS-NWFSC-15. National Marine Fisheries Service, Northwest Fisheries Science Center, Coastal Zone and Estuaries Studies Division, Seattle, Washington.

Jones, W. 1995. Caspar Creek downstream migrant trap--1995. Graphs and tables.

Kline, T. C., Jr., J. J. Goering, O. A. Mathisen, P. H. Poe, and P. L. Parker. 1990. Recycling of elements transported upstream by runs of Pacific salmon: I. $\delta^{15}N$ and $\delta^{13}C$ evidence in Sashin Creek, southeastern Alaska. Canadian Journal of Fisheries and Aquatic Sciences 47: 136-144.

Koski, K. V., J. Heifetz, S. Johnson, M. Murphy, and J. Thedinga. 1984. Evaluation of buffer strips for protection of salmonid rearing habitat and implications for enhancement. Pages 138-155 *in* T. J. Hassler, editor. Pacific Northwest stream habitat management workshop. California Cooperative Fisheries Unit, Humboldt State University, Arcata, California.

Koski, K. V. 1966. The survival of coho salmon (*Oncorhynchus kisutch*) from egg deposition to emergence in three Oregon coastal streams. Master's thesis. Oregon State University, Corvallis.

Kostow, K., editor. 1995. Biennial report on the status of wild fish in Oregon. Oregon Department of Fish and Wildlife, Portland.

Lauman, J. E., K. E. Thompson, and J. D. Fortune, Jr. 1972. Fish and wildlife resources of the Umpqua Basin, Oregon, and their water requirements. Federal Aid to Fish Restoration Completion Report, Fisheries Stream Flow Requirements. A report with recommendations to the Oregon State Water Resources Board from the Oregon State Game Commission, Portland.

Lawson, P. W. 1993. Cycles in ocean productivity, trends in habitat quality, and the restoration of salmon runs in Oregon. Fisheries (Bethesda) 18: 6-10.

Lightcap, S. W. 1994. Panther Creek stream survey report: a progress report based upon the compilation and analysis of summer low flow fish habitat inventory data collected in 1990 and 1991. USDA Forest Service, North Umpqua Ranger District, Umpqua National Forest, Glide, Oregon.

Lightcap, S. W., and T. J. La Marr. 1993. Fairy Creek basin fish habitat rehabilitation plan. USDA Forest Service, North Umpqua Ranger District, Umpqua National Forest, Glide, Oregon.

Loomis, D. 1997, 2001. Personal communication. Oregon Department of Fish and Wildlife, Roseburg.

Marsh, M. C., and F. P. Gorham. 1905. The gas disease in fishes. U. S. Bureau of Fisheries, Report of the U. S. Commission of Fisheries 1904: 343-376.

Mason, J. C. 1974. A further appraisal of the response to supplemental feeding of juvenile coho (*O. kisutch*) in an experimental stream. Technical Report 470. Fisheries and Marine Service, Pacific Biological Station, Nanaimo, British Columbia.

McCabe, G. T., Jr., W. D. Muir, R. L. Emmett, and J. T. Durkin. 1983. Interrelationships between juvenile salmonids and nonsalmonid fish in the Columbia River estuary. Fishery Bulletin 81: 815-826.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. NOAA Technical Memorandum NMFS-NWFSC-42. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

McFadden, J. T. 1969. Dynamics and regulation of salmonid populations in streams. Pages 313-329 *in* T. G. Northcote, editor. Symposium on salmon and trout in streams. H. R. MacMillan Lectures in Fisheries, University of British Columbia, Vancouver.

McMahon, T. E. 1983. Habitat suitability index models: coho salmon. Report FWS/OBS-82/10.49. U. S. Fish and Wildlife Service, Western Energy and Land Use Team, Washington, D. C.

McNeil, W. J. 1964. Redd superimposition and egg capacity of pink salmon spawning beds. Journal of the Fisheries Research Board of Canada 21: 1385-1396.

Meehan, W. R., and T. C. Bjornn. 1991. Salmonid distributions and life histories. Pages 47-82 *in* W. R. Meehan, editor. Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication No. 19. Bethesda, Maryland.

Mills, M. 1994. Re: Relicensing of the North Umpqua Hydroelectric Project. Letter to S. A. deSousa, Director, Hydro Resources, Portland, Oregon. From The Steamboaters, Idleyld Park, Oregon. 15 November.

Minshall, G. W. 1984. Aquatic insect-substratum relationships. Pages 358-400 *in* V. H. Resh and D. M. Rosenberg, editors. The ecology of aquatic insects. Praeger, New York.

Minshall, G. W., E. Hitchcock, and J. R. Barnes. 1991. Decomposition of rainbow trout (*Oncorhynchus mykiss*) carcasses in a forest stream ecosystem inhabited only by nonanadromous fish populations. Canadian Journal of Fisheries and Aquatic Sciences 48: 191-195.

Moore, D. G. 1975. Effects of forest fertilization with urea on stream water quality--Quilcene Ranger District, Washington. Research Note PNW-241. USDA Forest Service.

Moyle, P. B., J. E. Williams, and E. D. Wikramanayake. 1989. Fish species of special concern of California. Final Report. Prepared by Department of Wildlife and Fisheries Biology, University of California, Davis for California Department of Fish and Game, Inland Fisheries Division, Rancho Cordova.

Nicholas, J. 1988. Comprehensive plan for production and management of Oregon's anadromous salmon and trout. Part IV. Coastal chinook salmon plan. Draft Report Oregon Department of Fish and Wildlife, Research and Development Section, Corvallis.

Nicholas, J., and M. O'Mealy. 2000. The Oregon Plan for salmon and watersheds: Update 2000. State of Oregon, Salem.

Nickelson, T. E. 1986. Influences of upwelling, ocean temperature, and smolt abundance on marine survival of coho salmon (*Oncorhynchus kisutch*) in the Oregon Production Area. Canadian Journal of Fisheries and Aquatic Sciences 43: 527-535.

Nickelson, T. E., and P. W. Lawson. 1998. Population viability of coho salmon, *Oncorhynchus kisutch*, in Oregon coastal basins: application of a habitat-based life cycle model. Canadian Journal of Fisheries and Aquatic Sciences 55: 2383-2392.

Nickelson, T. E., M. F. Solazzi, S. L. Johnson, and J. D. Rodgers. 1992. An approach to determining stream carrying capacity and limiting habitat for coho salmon (*Oncorhynchus kisutch*). Pages 1-12 *in* L. Berg and P. W. Delaney, editors. Proceedings of the coho workshop. Pacific Biological Station, Nanaimo, British Columbia.

Nielsen, J. L. 1992. Microhabitat-specific foraging behavior, diet, and growth of juvenile coho salmon. Transactions of the American Fisheries Society 121: 617-634.

National Marine Fisheries Service (NMFS). 1995. Endangered and threatened species; proposed threatened status for three contiguous ESUs of coho salmon ranging from Oregon through central California. Federal Register 60: 38011-38030.

NMFS. 1996. Factors for decline: a supplement to the notice of determination for West Coast steelhead under the Endangered Species Act. NMFS, Protected Species Branch, Portland, Oregon and NMFS, Protected Species Management Division, Long Beach, California.

NMFS. 1996b. Making Endangered Species Act determinations of effect for individual or grouped actions at the watershed scale. Draft Report. NMFS, Environmental and Technical Services Division, Habitat Conservation Branch, Long Beach, California.

NMFS. 1997. Endangered and threatened species: threatened status for southern Oregon/northern California coast evolutionarily significant unit of coho salmon. Federal Register 62: 24588-24609.

NMFS. 1998a. Endangered and threatened species; threatened status for two ESUs of steelhead in Washington, Oregon, and California. Federal Register 63: 13347-13371.

NMFS. 1998b. Endangered and threatened species; threatened status for the Oregon Coast Evolutionarily Significant Unit of coho salmon. Federal Register 63: 42587-42591.

NMFS. 1999. The habitat approach: implementation of Section 7 of the Endangered Species Act for actions affecting the habitat of Pacific anadromous salmonids. NMFS, Northwest Region, Portland, Oregon.

NMFS. 2000. Designated critical habitat: critical habitat for 19 evolutionarily significant units of salmon and steelhead in Washington, Oregon, Idaho, and California. Federal Register 65: 7764-7787.

NMFS. 2001a. Revised Fishway Prescriptions, North Umpqua Hydroelectric Project.

NMFS. 2001b. Guidance for integrating Magnuson-Stevens Fishery Conservation and Management Act EFH consultations with Endangered Species Act Section 7 consultations.

Noggle, C. C. 1978. Behavioral, physiological and lethal effects of suspended sediment on juvenile salmonids. Master's thesis. University of Washington, Seattle.

O'Connor, M., and R. D. Harr. 1994. Bedload transport and large organic debris in steep mountain streams in forested watersheds on the Olympic Peninsula, Washington. Final Report No. TFW-SH7-94-001. Prepared by College of Forest Resources, University of Washington, Seattle and USDA Forest Service, Pacific Northwest Research Station for Sediment, Hydrology and Mass Wasting Steering Committee of the Timber/Fish/Wildlife Agreement, Washington Department of Natural Resources, Olympia.

OCSRI Science Team. 1996. Oregon coastal salmon restoration initiative: Oregon's plan for conservation and restoration of anadromous salmonids in coastal river basins. Draft Report.

Oregon Department of Fish and Wildlife (ODFW). 1986. North Umpqua River (below Soda Springs Dam) Fish Management Plan. ODFW, Roseburg.

ODFW. 1998. Graphs and figures on anadromous fish escapements in the Umpqua River basin. Portland, Oregon.

ODFW. 2000. Approximate periods of spawning through emergence for salmonids in various reaches of the North Umpqua Hydroelectric Project. Letter from Ken Homolka, Hydropower Coordinator, ODFW, to Dennis Belskey, Oregon Dept. of Environmental Quality, November 2, 2000.

OCSRI Science Team. 1996. Oregon coastal salmon restoration initiative: Oregon's plan for conservation and restoration of anadromous salmonids in coastal river basins. Draft Report.

PacifiCorp. 1994. Final technical report for aquatic resources study--70% draft. North Umpqua Hydroelectric Project, FERC Project No. 1927. Portland, Oregon.

PacifiCorp. 1995. Application for new license for major modified project. North Umpqua Hydroelectric Project, FERC Project No. 1927, Douglas County, Oregon. Portland, Oregon.

PacifiCorp. 1996. Ongoing water quality and aquatic studies--1995 report. North Umpqua Hydroelectric Project, FERC Project No. 1927, Douglas County, Oregon. Portland, Oregon.

PacifiCorp. 2001. North Umpqua Hydroelectric Project proposed surface water temperature management plan. Portland, Oregon.

PacifiCorp et al. 2001. Settlement agreement among PacifiCorp, USDA Forest Service, National Marine Fisheries Service, USDI Fish and Wildlife Service, USDI Bureau of Land Management, Oregon Department of Environmental Quality, Oregon Department of Fish and Wildlife, and Oregon Water Resources Department dated June 13, 2001 concerning the relicensing of the North Umpqua Hydroelectric Project, FERC Project No. 1927-008, Douglas County, Oregon.

PacifiCorp. 2002. North Umpqua Hydroelectric Project draft biological assessment and essential fish habitat assessment. Prepared by Stillwater Sciences, Berkeley, California for PacifiCorp, Portland, Oregon.

PacifiCorp. 2002a. Proposed surface water temperature management plan. February 19, 2002.

Pauley, G. B., and R. E. Nakatani. 1967. Histopathology of "gas-bubble" disease in salmon fingerlings. Journal of the Fisheries Research of Canada 24: 867-871.

Pearcy, W. G., et al. 1992. Oregon Coastal Natural Coho Review Team report: an assessment of the status of the Oregon Coastal Natural coho stock as required under the definition of overfishing. Pacific Fishery Management Council, Portland, Oregon.

Peterman, R. M. 1982. Model of salmon age structure and its use in preseason forecasting and studies of marine survival. Canadian Journal of Fisheries and Aquatic Sciences 39: 1444-1452.

Powell, M. 1996. Recovery of Oregon's coastal salmonids. Colliding Rivers Research, Inc., Corvallis, Oregon.

Powell. 1997. Personal communication. Colliding Rivers Research, Inc., Corvalis, Oregon.

Ratner, S., R. Lande, and B. B. Roper. 1997. Population viability analysis of spring chinook salmon in the South Umpqua River, Oregon. Conservation Biology

Redmond, K. 1993. Climate variability at Crater Lake National Park and its effect upon water level. Final Technical Report No. NPS/PNR/PNROSU/NRTR-93/03. G. L. Larson, C. D. McIntire and R. W. Jacobs, editors. Crater Lake limnological studies. National Park Service, Seattle, Washington.

Rodgers, J. D. 1986. The winter distribution, movement, and smolt transformation of juvenile coho salmon in an Oregon coastal stream. Master's thesis. Oregon State University, Corvallis.

Sandercock, F. K. 1991. Life history of coho salmon (*Oncorhynchus kisutch*). Pages 397-445 *in* C. Groot and L. Margolis, editors. Pacific salmon life histories. University of British Columbia Press, Vancouver, B. C.

Shapovalov, L., and W. Berrian. 1940. An experiment in hatching silver salmon (*Oncorhynchus kisutch*) eggs in gravel. Transactions of the American Fisheries Society 69: 135-140.

Shapovalov, L., and A. C. Taft. 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri gairdneri*) and silver salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and recommendations regarding their management. Fish Bulletin 98. California Department of Fish and Game.

Sherrod, D. R. 1986. Geology, petrology, and volcanic history of a portion of the Cascade Range between latitudes 43º to 44º N, central Oregon, USA. Doctoral dissertation. University of California, Santa Barbara.

Sigler, J. W., T. C. Bjornn, and F. H. Everest. 1984. Effects of chronic turbidity on density and growth of steelheads and coho salmon. Transactions of the American Fisheries Society 113: 142-150.

Sorenson, D. L., M. M. McCarthy, E. J. Middlebrooks, and D. B. Porcella. 1977. Suspended and dissolved solids effects on freshwater biota: a review. Research Report E. T. A.-600/3-77-042. Environmental Protection Agency, Office of Research and Development.

Stein, R. A., P. E. Reimers, and J. D. Hall. 1972. Social interaction between juvenile coho (*Oncorhynchus kisutch*) and fall chinook salmon (*Oncorhynchus tshawytscha*) in Sixes River, Oregon. Journal of the Fisheries Research Board of Canada 29: 1737-1748.

Stevens, D. G., A. V. Nebeker, and R. J. Baker. 1980. Avoidance responses of salmon and trout to air-supersaturated water. Transactions of the American Fisheries Society 109: 751-754.

Stillwater Sciences. 1998. The North Umpqua cooperative watershed analysis synthesis report. Prepared by Stillwater Sciences, Berkeley, California for PacifiCorp, Portland, Oregon.

Stillwater Sciences. 2000. Assessment of spawning gravel in the North Umpqua River reach upstream of Slide Creek Dam. Response to Mediation Team information request. Prepared by Stillwater Sciences, Berkeley, California for PacifiCorp, Portland, Oregon.

Tagart, J. V. 1984. Coho salmon survival from egg deposition to emergence. Pages 173-181 *in* J. M. Walton and D. B. Houston, editors. Proceedings of the Olympic wild fish conference. Peninsula College, Port Angeles, Washington.

Thomas, J. L. 1967. The diet of juvenile and adult striped bass, *Roccus saxatilis*, in the Sacramento-San Joaquin river system. California Fish and Game 53: 49-62.

Tschaplinski, P. J., and G. F. Hartman. 1983. Winter distribution of juvenile coho salmon (*Oncorhynchus kisutch*) before and after logging in Carnation Creek, British Columbia, and some implications for overwinter survival. Canadian Journal of Fisheries and Aquatic Sciences 40: 452-461.

U. S. Army Corps of Engineers (USACE). 1992. 1992 Dissolved gas monitoring for the Columbia and Snake rivers. USACE, North Pacific Division, Reservoir Control Center, Water Management Division, Portland, Oregon.

USDA Forest Service. 1990. Umpqua National Forest land and resource management plan. USDA Forest Service, Pacific Northwest Region, Umpqua National Forest, Roseburg, Oregon.

USDA Forest Service. 1993. Wild and Scenic River suitability study for Steamboat Creek. Draft Legislative Environmental Impact Statement. Umpqua National Forest, Roseburg, Oregon.

USDA Forest Service. 1995. Cited on page 137, section 4.

USDA Forest Service. 1996a. Upper Clearwater watershed analysis. Diamond Lake Ranger District, Idleyld Park, Oregon.

USDA Forest Service. 1996b. 1993 and 1995 North Umpqua River spring chinook salmon redd counts: a progress report. Umpqua National Forest, Roseburg, Oregon.

USDA Forest Service. 1997a. Upper North Umpqua watershed analysis. Draft report. Diamond Lake Ranger District, Idleyld Park, Oregon.

USDA Forest Service. 1997b. Upper Steamboat Creek watershed analysis--1997. North Umpqua Ranger District, Umpqua National Forest, Glide, Oregon.

USDA Forest Service 2000a and 2000b. Cited on page 112, section 4.

USDA Forest Service and USDI Bureau of Land Management. 1994. Record of decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl and Standards and guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl.

USDA Forest Service and USDI Bureau of Land Management. 1995. Little River watershed analysis. Version 1.1. North Umpqua Ranger District, Umpqua National Forest, Glide, Oregon and USDI Bureau of Land Management, Mt. Scott Resource Area.

USDA Forest Service Umpqua National Forest, Oregon State Parks and Recreation Department, and U. S. Bureau of Land Management Roseburg District. 1992. North Umpqua Wild and Scenic River. Environmental Assessment.

USDA Forest Service Umpqua National Forest, USDI Bureau of Land Management Roseburg District, and Oregon Department of Fish and Wildlife. 1994. Canton Creek preliminary watershed assessment: executive summary, appendices, and associated project proposals. Roseburg, Oregon.

USDI Bureau of Land Management. 1995. Watershed analysis--Canton Creek. USBLM, Roseburg, Oregon.

USDI Bureau of Land Management. 1996. Watershed analysis--Rock Creek. USBLM, Roseburg, Oregon.

Vanderbilt, K. L., K. Lajtha, and F. J. Swanson. 1996. Nitrogen fluxes in experimental watersheds in western Oregon. Abstracts of the Chapman Conference on nitrogen cycling in forested catchments. American Geophysical Union.

Vannote, R. L., G. W. Minshall, K. W. Cummins, J. R. Sedell, and C. E. Cushing. 1980. The river continuum concept. Canadian Journal of Fisheries and Aquatic Sciences 37: 130-137.

Velsen, F. P. J. 1987. Temperature and incubation in Pacific salmon and rainbow trout: compilation of data on mean hatching time, mortality and embryonic staging. Canadian Report of Fisheries and Aquatic Sciences 626.

Walling, A. G. 1884. History of southern Oregon comprising Jackson, Josephine, Douglas, Curry, and Coos counties, compiled from the Most Authentic Sources. Portland, Oregon.

Ward, B. R., P. A. Slaney, A. R. Facchin, and R. W. Land. 1989. Size-biased survival in steelhead trout (*Oncorhynchus mykiss*): back-calculated lengths from adults' scales compared to migrating smolts at the Keogh River, British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 46: 1853-1858.